UNITED STATES. CIRCUIT COURT. DISTRICT
OF NEW JERSEY.

New Jersey Patent Company )
vs. ) In Equity
Columbia Phonograph Company, ) On Lttrs.
General. ) Patent
No.782375

RECORD.
TESTIMONY.
1905-

# CIRCUIT COURT OF THE UNITED STATES

## District of New Jersey.

NEW JERSEY PATENT COMPANY

*vs.*

COLUMBIA PHONOGRAPH COMPANY, GENERAL.

In Equity. On Letters Patent No. 782,375.

# RECORD.

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*Of Counsel.*

PHILIP MAURO,
*Solicitor for Defendant.*

PHILIP MAURO,
C. A. L. MASSIE,
*Of Counsel.*

MacCrellish & Quigley, Book and Job Printers, Trenton, N. J.

# CIRCUIT COURT OF THE UNITED STATES

## District of New Jersey.

NEW JERSEY PATENT COMPANY

*vs.*

COLUMBIA PHONOGRAPH COMPANY, GENERAL.

In Equity. On Letter's Patent No. 782,375.

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United States Circuit Court, District of New Jersey.

NEW JERSEY PATENT COMPANY,
*Complainant,*
*vs.*
COLUMBIA PHONOGRAPH COMPANY, GENERAL,
*Defendant.*

Bill in Equity on Letters Patent No. 782,375.

## Bill of Complaint.

*(Filed April 3, 1905.)*

To the Honorable the Judges of the United States Circuit Court for the District of New Jersey.

NEW JERSEY PATENT COMPANY, a corporation created, organized and existing under and by virtue of the laws of the State of New Jersey and having its principal office at West Orange, County of Essex, in said State, brings this, its bill of complaint against COLUMBIA PHONOGRAPH COMPANY, GENERAL, a corporation created, organized and existing under and by virtue of the laws of the State of West Virginia, and having a regular and established place of business at Paterson in the District of New Jersey, wherein some of the acts of infringement hereinafter complained of were committed.

And thereupon your orator complains and says:

1. That heretofore and before the 29th day of October, 1903, Jonas W. Aylsworth of East Orange in the State of New Jersey and a citizen of the United States was the original, first and sole inventor of a certain new and useful improvement in Compositions for Making Duplicate Phonograph Records, fully described in the Letters Patent hereinafter mentioned, and which had not been known or used by others in this country before his invention or discovery thereof, and which had not been patented or described in any printed publication in this or any foreign country before his invention or discovery thereof, or more than two years prior to his application for Letters Patent therefor hereinafter mentioned, and which had not been patented or caused to be patented by the said inventor or his legal representatives or assigns in a country foreign to the United States on an application filed more than twelve months prior to his said application for Letters Patent of the United States, and which had not been in public use or

on sale in the United States for more than two years prior to his said application, and which had not been abandoned.

2. That on or about the said 29th day of October, 1903, the said Jonas W. Aylsworth, by an instrument in writing bearing that date duly signed and delivered, and recorded in the United States Patent Office on the 5th day of November, 1903, did sell, assign and transfer to your orator, New Jersey Patent Company, its successors or assigns, the entire right, title and interest in and to the aforesaid invention and in and to any Letters Patent of the United States which might be granted therefor, as by reference to said instrument, or to a duly authenticated copy thereof, ready in Court to be produced, will more fully and at large appear.

3. That on the 3d day of November, 1903, the said Jonas W. Aylesworth being as aforesaid the original, first and sole inventor or discoverer of the said composition, made application in writing to the Commissioner of Patents of the United States for the grant of Letters Patent therefor, and paid into the Treasury of the United States the fees required by law and then and there fully and in all respects, complied with all the necessary conditions and requirements of the statutes of the United States in such case made and provided. And thereupon, due examination having been made by the Commissioner of Patents as to the novelty and utility of the said invention as provided by law, the Commissioner of Patents caused to be issued to your orator, New Jersey Patent Company, Letters Patent in due form of law, under the seal of the Patent Office of the United States, signed by the Commissioner of Patents and bearing date the 14th day of February, 1905, and numbered 782,375; and that the said Letters Patent did grant unto your orator and unto its successors and assigns for the term of seventeen years from the date thereof, the exclusive right to make, use and vend the said invention throughout the United States and the territories thereof, as by reference to said Letters Patent or to a duly authenticated copy thereof, ready in Court to be produced, will more fully and at large appear.

4. That your orator is now the sole and exclusive owner of the said Letters Patent No. 782,375, and of all claims for infringement and violation thereof.

5. That the said invention is of great public utility and has been introduced into extensive public use by your orator and its licensee, National Phonograph Company; and that your orator and its said licensee, have at all times stood ready and still stand ready and are able to supply all public demands for said invention.

6. That the defendant, well knowing the premises, and the rights secured to your orator as aforesaid, but contriving to injure your orator and to deprive your orator of the benefits and advantages which might and otherwise would accrue unto your orator from the said invention, after the grant of said Letters Patent No. 782,375 and before the commencement of this suit, as your orator is informed and believes and therefore avers, within the District of Jersey and elsewhere in the United States, without license or allowance and against the protest of your orator and in violation of its rights, did, unlawfully and wrongfully make, use and sell, and cause to be made, used and sold, and that it is now making, using and selling, and causing to be made, used and sold, in the City of Paterson, State of New Jersey, and in said District aforesaid, phonograph record compositions, employing, and containing the invention set forth in said Letters Patent No. 782,375; that said defendant still continues so to do, and that it is threatening to continue the aforesaid unlawful acts to a large extent, all in defiance of the rights secured to your orator as aforesaid, and to its great irreparable loss and injury, and by which your orator has been, and still is being deprived of great gains and profits which it might and otherwise would have obtained, but which have been received and enjoyed by the said defendant through its said unlawful acts and doings. And your orator further shows that it has caused notice to be given to said defendant of said infringement and of the rights of your orator in the premises and requested defendant to desist and refrain therefrom, but that said defendant disregarded said notice and refused to desist from said infringement and still continues to make, use and sell phonograph records embodying and containing said invention. And your orator further shows that as to the number of records employing or containing or making use of said composition which have been by the defendant as aforesaid unlawfully made, used or sold, and as to the extent of the gains and profits received and enjoyed by said defendant from such unlawful making or using or selling, your orator is ignorant and prays a discovery thereof.

8. And your orator therefore prays as follows:

That the defendant may be required by a decree of this Honorable Court to account for and pay over to your orator such gains and profits as have accrued or arisen, or been earned or received by the said defendant by reason of the said unlawful doings, and all such gains and profits as would have accrued to your orator but for the unlawful doings of said defendant, and all damages your orator has sustained thereby, and that the Court may assess said profits and damages and may increase the damages to a sum not exceeding three times the amount thereof.

That the defendant and its associates, officers, attorneys, servants, clerks, agents and workmen, may be perpetually enjoined and restrained by writ of injunction issued out of and under the seal of this Honorable Court, from directly or indirectly making or causing to be made, using or causing to be used, or selling or causing to be sold, any phonograph records embodying, employing or containing the invention and improvement set forth and claimed in the said Letters Patent numbered 782,375 or from infringing upon or violating the said Letters Patent in any way whatsoever.

That your Honors will grant unto your orator a preliminary injunction issuing out of and under the seal of this Honorable Court, enjoining and restraining the said defendant, and its associates, officers, attorneys, servants, clerks, agents and workmen, to the same purpose, tenor and effect as hereinbefore prayed for with regard to the said perpetual injunction.

That the said defendant may be decreed to pay the costs of this suit; and

That your orator may have such other further relief as the equity of the case may require.

To the end therefore, that the said defendant may, if it can, show why your orator should not have the relief prayed for, and may full, true and direct answer make, but not under oath (answer under oath being hereby expressly waived), according to the best and utmost of its knowledge, remembrance and belief, to the several matters hereinbefore averred and set forth, as fully and particularly as if the same were repeated paragraph by paragraph, and the said defendant specifically interrogated, may it please your Honors to grant unto your orator a writ of *subpœna ad respondendum*, issuing out of and under the seal of this Honorable Court, directed to the said defendant, Columbia Phonograph Company, General, commanding it to appear and make answer to this Bill of Complaint, and to perform and abide by such orders and decrees herein, as to this Court may seem just.

And your orator will ever pray, etc.

NEW JERSEY PATENT COMPANY.
By JOHN F. RANDOLPH,
*Secretary.*

FRANK L. DYER,
*Solicitor for Complainant.*

FRANK L. DYER,
DELOS HOLDEN,
*Of Counsel.*

State of New Jersey, }
*County of Essex.* } *ss.*

John F. Randolph, being duly sworn, deposes and says that he is the Secretary of New Jersey Patent Company, the complainant named in the foregoing Bill of Complaint; that he has read the same and knows the contents thereof to be true except as to those matters stated to be alleged on information and belief, and as to those matters he believes it to be true; that the reason why his verification is not made by the complainant personally is because it is a corporation.

JOHN F. RANDOLPH.

Subscribed and sworn to before me this 1st day of April, 1905.

FRANK L. DYER,
[L. S.] *Notary Public, State of New Jersey,*
*Commission Expires February, 1908.*

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In the Circuit Court of the United States, District of New Jersey.

New Jersey Patent Company,
*Complainant,*
*vs.*
Columbia Phonograph Co., Genl.,
*Defendant.*

In Equity No.
Suit on Patent
No. 782,375.

## Answer to Bill of Complaint.

*(Filed June 5, 1905.)*

The defendant, the Columbia Phonograph Co., General, answering to the bill of complaint herein, or to so much thereof as it is advised is material and proper to be answered unto, answering says: That it, the defendant, is a West Virginia corporation and has a place of business at Paterson, New Jersey, and that it believes the complainant to be a New Jersey corporation, as alleged in said bill of complant.

And further answering, said defendant says:

I.

Defendant denies each and every allegation of paragraph numbered 1 in said bill of complaint.

## II.

Defendant is not informed, save by said bill of complaint touching the matters alleged in paragraph 2 thereof, and therefore demands proof thereof.

## III.

Defendant admits the issue of letters patent No. 782,375 to complainant, but denies that the same were issued in conformity with law, and denies that complainant derived any exclusive rights thereunder.

## IV.

Defendant is not informed, save by said bill, touching the allegation of paragraph 4 thereof, and therefore demands proof of the same.

## V.

Defendant denies that the alleged invention is of great public utility, and is not informed of the extent of use of the same or of complainant's ability to supply the demand therefor.

## VI.

Defendant denies that it has made, used and sold, or caused to be made, used and sold, in the district aforesaid and elsewhere in the United States, compositions employing and containing the said alleged invention; and denies each and every allegation of paragraph No. 6 of said bill of complaint.

## VII.

Without waiving any defense hereinbefore set up, defendant further answering upon information and belief avers that none of the various matters, things and combinations described and claimed in said patent No. 782,375 is the result of an inventive act, or was novel at the time of the alleged invention thereof by the said Aylesworth; but on the contrary, each of said matters and things was well known to persons skilled in the art to which said alleged invention relates, and was not the proper subject-matter of letters patent under the laws of the United States.

## VIII.

And this defendant further avers that, for the purpose of deceiving the public, the description and specification filed by the applicant for said patent in the United States Patent Office was made to contain less than the whole truth relative to the said alleged invention or discovery, or more than is necessary to produce the desired effect.

## IX.

And this defendant further answering, upon information and belief, avers that the alleged invention of said patent No. 782,375, or material and substantial parts thereof were, prior to the supposed invention or discovery thereof by said Aylesworth, disclosed and patented in the following Letters-patent of the United States:

| *Number.* | *Patentee.* | *Date.* |
|---|---|---|
| 341,214. | Bell & Tainter, | May 4, 1886. |
| 393,190. | C. S. Tainter, | Nov. 20, 1888. |
| 400,648. | T. A. Edison, | April 2, 1889. |
| 406,576, | T. A. Edison, | July 9, 1889. |
| 414,759. | T. A. Edison, | Nov. 12, 1889. |
| 421,450. | C. S. Tainter, | Feb. 18, 1890. |
| 430,274. | T. A. Edison, | June 17, 1890, |
| 484,582, | T. A. Edison, | Oct. 18, 1892. |
| 606,725, | Macdonald, | July 5, 1898. |
| 626,709, | Macdonald, | June 13, 1899. |
| 676,111, | Aylesworth, | June 11, 1901. |

## X.

And further answering, this defendant upon information and belief avers that said Aylesworth was not the original inventor of any material or substantial part of the things purporting to be patented in and by said patent No. 782,375: but that the same had long before been known to and used by others, to wit:

Charles Sumner Tainter, then of and at Washington, D. C.
Thomas H. Macdonald, of and at Bridgeport, Connecticut.

Thomas A. Edison, of and at Orange, New Jersey; and that the said alleged invention had been in public use or on sale in the United States for more than two years before the date of application for said patent No. 782,375, by each of the above-named persons at the places aforesaid and elsewhere.

## XI.

Further this defendant avers in answer to said bill of complaint that in the state of the art and of public knowledge at the time of the alleged invention by said Aylesworth, the various matters and things set forth and claimed in said patent No. 782,375 were wanting in patentable novelty and invention.

All of which matters and things this defendant is ready to maintain and prove as this Honorable Court shall direct and prays to be hence dismissed with its reasonable costs and charges in this behalf most wrongfully sustained.

COLUMBIA PHONOGRAPH COMPANY, GEN'L.,
By EDW. GARWOOD,
*Sec'y.*

PHILIP MAUROW,
*90 West Broadway, New York.*
*Solicitor for Defendant.*

PHILIP MAUROW,
C. A. L. MASSIE,
*Of Counsel.*

---

United States Circuit Court, District of New Jersey.

NEW JERSEY PATENT COMPANY,
*Complainant,*
*vs.*
COLUMBIA PHONOGRAPH COMPANY, GENERAL,
*Defendant.*

In Equity:
No. 12 March
Term. On
Letters
Patent
No. 728,375.

## Replication.

*(Filed July 3, 1905.)*

The replication of the above named complainant to the answer of the above named defendant.

This replicant, saving and reserving to itself all and all manner of advantage of exception which may be had and taken to the manifold errors, uncertainties and insufficiencies of the answer of said defendant, for replication thereunto sayeth:

That it does and will ever maintain and prove its said bill to be true, certain and sufficient in law to be answered unto by said defendant, and that the answer of said defendant is very uncertain, evasive and insufficient in the law to be replied unto by this replicant; without that, that any other matter or thing in the said answer contained material or effectual in the law to be replied unto, and not herein and hereby well and sufficiently replied unto, confessed or avoided, traversed or denied, is true; all which matters and things this replicant is ready to aver, maintain and prove, as this Honorable Court shall direct and humbly as in and by its said bill it has already prayed.

FRANK L. DYER,
*Solicitor for Complainant.*

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United State Circuit Court, District of New Jersey.

NEW JERSEY PATENT COMPANY,
*Complainant,*
*vs.*
COLUMBIA PHONOGRAPH COMPANY, GENERAL,
*Defendant.*

In Equity, No. 12, March Term, on Letters Patent No. 782,375.

## Complainant's Proofs.

*(Filed September 28, 1905.)*

WEST ORANGE, N. J., July 26th, 1905.

Testimony for final hearing taken for complainant pursuant to the 67th Rule at the Edison Laboratory, before Henry D. Oliphant, Esq., a standing examiner of this Court.

Present—MELVILLE CHURCH, Esq., and FRANK L. DYER, Esq., for complainant; C. A. L. MASSIE, Esq., for defendant.

Certified copy of patent to Aylsworth, No. 782,375 dated February 14th, 1905, offered in evidence and marked "Complainant's Exhibit, patent in suit." It is stipulated that the title to the Aylsworth patent in suit is in the complainant corporation.

It is also stipulated that printed Patent Office copies of United States patents, and British blue-book copies of British patents may be used with the same force and effect as if duly and regularly certified, subject to correction if necessary.

Defendant admits that defendant, subsequent to the grant of the Aylsworth patent in suit, and before the filing of the bill of complaint herein, sold in this district and elsewhere, molded sound records supplied to the defendant by American Graphophone Company, and that such molded sound records were formed of a composition prepared as follows:

Stearic acid is first melted and saponified by the addition of an alkaline solution (caustic soda lye and carbonate of soda) the proportion of alkali used being insufficient to completely saponify all the stearic acid present, so that a considerable proportion of the stearic acid exists as free or excessive stearic acid. Before the alkaline solution is added to the stearic acid, metallic aluminum or aluminum hydrate is added to the alkaline solution, so as to dissolve therein, forming with a portion thereof, aluminate of soda. After the saponification has taken place, ceresin is added to the same, and either before or after the addition of ceresin, carnauba wax is added to the heated mixture, the temperature of the latter being raised to from 450 to 475 degrees F. A black coloring substance is also employed to give to the finished product a uniform dark appearance.

It is stipulated that on February 20th, 1905, twelve Columbia records, formed of a composition made as above described, were purchased by one of the complainant's employees from the defendant corporation at its store at Paterson, New Jersey, in this District, and that these Columbia records were analyzed by Jonas W. Aylsworth, a chemist in the employ of the National Phonograph Company.

Jonas W. Aylsworth, a witness called on behalf of complainant, having been first duly sworn, deposes and says as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. Give your name, age, residence and occupation.

*A.* Jonas W. Aylsworth, age 36, residence 223 Midland Avenue, East Orange, New Jersey. I am a chemist employed by the National Phonograph Company.

*Q.* 2. Are you the inventor of the composition for making duplicate phonograph records covered by the Aylsworth patent in suit? *A.* I am.

*Q.* 3. What experience have you had with chemical matters, and particularly in connection with compositions for use in the phonographic art for record materials?

*A.* I have been since 1888, or the latter part of 1887, connected with the Edison Laboratory as an experimenter and in analytic work. The greater part of that time has been spent in work in connection with compositions for use on the phonograph. I have made thousands of experiments on record compositions, and have superintended the manufacture of the compositions used by the National Phonograph Company and its predecessors.

*Q.* 4. Are you familiar with the composition of carnauba wax, and if so, please state the composition thereof.

*A.* It is composed chiefly of myricyl alcohol, combined with cerotic acid, and myricyl alcohol in the free state, and small percentages of other alcohols and acids in which the percentage does not exceed 5 per cent. in the average lots of carnauba wax.

*Q.* 5. If carnauba wax is added to a record composition, containing free stearic acid at a temperature of about 450 degrees F., as stated in the patent in suit, what chemical combination, if any, will be effected?

*A.* The free myricyl alcohol of the carnauba wax will combine with free stearic acid to form a compound, known as an ether, or compound ether. The evidence of the formation of such a compound is observed when the materials are mixed by the elimination of gas, which causes the material to froth and foam for a considerable time after the addition of the carnauba to the previously tranquil composition; that is to say, a composition free from froth and foam previous to the addition of the carnauba. Also, by the different nature of material which is produced if carnauba wax is added to a stearate of soda composition, containing an excess of stearic acid, where the temperature is not raised sufficiently to cause such combination to take place. Also by the results of the analyses.

*Q.* 6. Of what nature or character is the compound ether to which you have just referred? *A.* It is a wax-like compound.

*Q.* 7. When did you make analyses of Columbia records sold by defendant prior to the filing of the bill and subsequent to the grant of the patent in suit, as admitted in the stipulation heretofore made?

*A.* The first one in March, 1905, and a final and complete analysis in June and July, 1905.

*Q.* 8. What was the result of your analysis of the twelve Columbia records referred to in the above stipulation, and please make a comparison of your result with the composition described by the patent in suit?

*A.* I used two of these Columbia records in my preliminary analysis, and six of them in my final analysis. As a result of my analysis of the Columbia composition, and putting the comparison of the patent in suit in corresponding terms, a comparison of the two would show the following percentages of materials:

| | *Alysworth pat.* | *Columbia comp.* |
|---|---|---|
| Stearic acid, .................. | 66.66 per cent. | 71.8 per cent. |
| Sodium oxide ($Na_2O$) as it exists in combination with stearic acid in the finished compound, .................. | 3.55 | 3.8 |
| Carnauba wax, from which the compound ethers present were derived, .................. | 14.24 | 7.8 |
| Non-hygroscopic hydrocarbon, ceresin, paraffine, ozocerite, or a combination thereof, ... | 14.24 | 14.3 |
| Aluminum oxide (the form in which it exists in combination with stearic acid in the finished composition), ........ | .47 | .7 |
| Black coloring material, ...... | .82 | small per cent. |

*Q.* 9. When a solution of caustic soda or carbonate of soda, or both, is added to stearic acid, and the resulting mixture maintained in a heated condition above the melting point of the stearic acid, what combination, if any takes place?

*A.* Stearate of soda is formed, the carbonic acid of the carbonate of soda and the water of the caustic soda being eliminated.

*Q.* 10. Is stearate of soda a metallic soap? *A.* Yes.

*Q.* 11. In the making up of a record composition as described in your patent in suit, is the entire amount of stearic saponified, or is there any free or excessive stearic acid present?

*A.* The entire amount is not saponified; there is a large excess of free stearic acid.

*Q.* 12. When metallic aluminum or aluminum hydrate, or aluminum oxide is added to a colution of caustic soda, or carbonate of soda, or both, what combination, if any, is formed?

*A.* When metallic aluminum or hydrate aluminum is added to a mixture of caustic and carbonate soda, aluminate of soda is produced.

*Q.* 13. When an alkaline solution containing aluminate of soda is added to a composition containing free stearic acid in the presence of heat, what combination, if any is affected?

*A.* The aluminate of soda is decomposed with the formation of stearate of soda and stearate of alumina.

*Q.* 14. Defendant has admitted that in the manufacture of the composition from which its records are made, the composition is heated to a temperature of between 450 to 475 degrees F. Would such a temperature result in the formation of a compound ether such as you have previously referred to?

*A.* It would, and as my analysis shows such a compound ether is present in defendant's composition.

*Q.* 15. Will you please produce samples of the separate ingredients employed in the manufacture of the composition described in the patent in suit?

*A.* I produce a bottle of stearic acid, also a bottle of caustic soda, also a bottle containing ceresin, also a bottle containing carbonate of soda, sodium carbonate or sal soda; also a bottle containing metallic aluminum; also a bottle containing carnauba wax; and finally, a bottle of lamp black.

The exhibits referred to by the witness offered in evidence and marked respectively—"Complainant's Exhibit, Stearic acid Sample," "Complainant's Exhibit, Caustic Soda Sample," "Complainant's Exhibit, Ceresin Sample," "Complainant's Exhibit, Carbonate of Soda Sample," "Complainant's Exhibit, Metallic Aluminum Sample," "Complainant's Exhibit, Carnauba Wax Sample," "Complainant's Exhibit, Lamp Black Sample."

*Q.* 16. Will you produce a sample of the alkaline solution after the aluminum has been dissolved therein?

*A.* I produce a bottle containing this solution.

> Offered in evidence and marked "Complainant's Exhibit, Solution of Aluminate of Soda."

*Q.* 17. Will you also produce a sample of the soap composition referred to in your patent as the same would exist prior to the addition of carnauba wax or ceresin?

*A.* I produce a bottle containing this soap mixture.

> Offered in evidence and marked "Complainant's Exhibit, Metallic Soap Mixture without carnauba or ceresin."

*Q.* 18. Will you also produce a sample of the composition described in your patent without ceresin or lamp black?

*A.* I produce a bottle containing a sample of the composition described in my patent, without ceresin or lamp black.

> Offered in evidence and marked "Complainant's Exhibit, Metallic Soap Mixture with Carnauba Wax, without Ceresin or Lamp Black."

*Q.* 19. Will you also produce a sample of the composition described in your patent without the lamp black?

*A.* I produce a bottle containing a sample of the finished material without the lamp black.

Offered in evidence and marked "Complainant's Exhibit, Finished material without lamp black."

*Q.* 20. Will you also produce a sample of the finished composition described in your patent?

*A.* I produce a bottle containing samples of the finished composition.

Offered in evidence and marked "Complainant's Exhibit, Finished Composition."

*Q.* 21. After you made your analyses of defendant's Columbia records, did you ever attempt to reproduce the composition as thus determined by you? *A.* I did.

*Q.* 22. Did you ever make a record from that composition?

*A.* I have, and produce the same.

The record referred to is offered in evidence and marked "Complainant's Exhibit, Aylsworth Columbia Record."

*Q.* 23. Have you also recently made records from the exact composition described in the patent in suit?

*A.* I have and produce the same.

The record referred to is offered in evidence and marked "Complainant's Exhibit, Aylsworth patent record."

*Q.* 24. Have you also recently made molded phonograph records from the usual blank composition in existence before the date of the patent in suit?

*A.* I have and produce such a record made from the composition which has been used for many years by the National Phonograph Company for the manufacture of phonograph blanks.

Record referred to offered in evidence and marked "Complainant's Exhibit, Record of Blank Wax."

*Q.* 25. Did you ever have occasion to experiment with the composition used in the Columbia records for the purpose of determining the physical characteristics thereof?

*A.* Yes, I caused to be purchased quite a large number of Columbia records shortly before making my preliminary analysis and made close observation of the compositions of the same under the effect of heat, and particularly with regard to the phenomena attending its cooling.

For the purpose of this suit and subject to correction by proof under notice, defendant admits that the composition of the Columbia records referred to by the witness is the same as the composition of those analyzed by the witness and referred to in his testimony.

*Q.* 26. Did you find that the Columbia composition was or was not very limpid when in a molten state? *A.* It was.

*Q.* 27. Was it free of decomposition products? *A.* Yes.

*Q.* 28. Did you observe whether under heat any gas bubbles were generated?

*A.* In re-melting the Columbia records, a little moisture was given off, but this is also true of our own records which have been re-melted after standing for some time.

*Q.* 29. What peculiarities of the Columbia composition did you observe when the composition passed from the liquid to the solid state?

*A.* That it passed through an intermediate condition of plasticity from the liquid to the solid state.

*Q.* 30. Did you observe that the Columbia composition was sticky or tenacious so as to adhere to the mold?

*A.* It was not.

*Q.* 31. Did the Columbia composition, when quite hard, shrink away from the mold by a reduction in its temperature?

*A.* It did.

*Q.* 32. Did it shrink uniformly or otherwise?

*A.* It shrunk uniformly and without warping.

*Q.* 33. Is the Columbia composition one that would or would not be affected by moisture?

*A.* It would not be affected by moisture.

*Q.* 34. What was the substantial melting point of the Columbia composition? *A.* About 250 degrees F.

Counsel for Complainant offers in evidence two of the Columbia records of the lot admitted to have been purchased at Paterson, N. J., and analyzed by the witness and the same are marked "Complainant's Exhibit Commercial Records."

CROSS-EXAMINATION, by Mr. MASSIE:

*xQ.* 35. In your patent you say that commercial stearic acid is generally a mixture of stearic acid and palmitic acid; what is the purpose of taking the pamitic acid?

*A.* Because that is the only form that you can buy. You cannot buy pure stearic acid, as manufactured stearic acid always contains a certain proportion of palmitic acid, usually about 50 per cent. Stearic and palmitic acids are very closely allied, and the effect of one is substantially the same as that of the other.

*xQ.* 36. In obtaining your alkaline solution, you employ both sodium carbonate and caustic soda. Why do you take each of these?

*A.* Because carbonate of soda alone will not dissolve the aluminium metal or the hydrate of aluminium and form aluminate of soda. You could use all caustic soda, but the carbonate of soda is easier to handle.

*xQ.* 37. What is the purpose of aluminium?

*A.* It prevents the tendency of the sodium compound with stearic acid to crystalize.

*xQ.* 38. If you take your alkaline solution in which the aluminum has been dissolved and the melted stearic acid and mix them and heat the mixture to about 450 degrees F. will the chemical re-actions which you have named in your direct examination take place without any interposition on the part of the experimentor?

*A.* They will take place, but the process is facilitated by stirring on the part of the operator.

*xQ.* 39. That is, if one takes the molten stearic acid and the alkaline solution in which the aluminum has been dissolved and puts them together and applies heat at the temperature indicated, and continues the process long enough, those re-actions will inevitably take place?

*A.* They will, but the operator mixing them would need to use certain caution in putting the ingredients together, or the re-actions will take place so rapidly as to cause all the material to foam out of the vessel in which it is made.

*xQ.* 40. That is, if the operator adds the alkaline solution gradually and takes pains to avoid violent ebullition, the result stated in your direct examination would inevitably follow?

*A.* Yes, but violent ebullition could not be avoided. The alkaline solution must be added so slowly, that the ebullition is not so violent as to overflow the vessel in which the operation is carried on.

*xQ.* 41. If instead of employing a temperature of 450 degrees F. you employ a temperature of only about 300 degrees F. and continue that temperature a long enough time, would the same results be produced?

*A.* The same re-actions would be produced.

*xQ.* 42. And you would then have the metallic soap mixture without carnauba, without ceresin or lamp black, such as is shown in "Complainant's Exhibit, Metallic soap without carnauba or ceresin wax and without lamp black"? *A.* Yes.

*xQ.* 43. Referring to this sample, can that material be employed for making sound records? *A.* It can be employed.

*xQ.* 44. Can it be employed for making molded records?

*A.* Not successfully.

*xQ.* 45. What would be the difficulties or objections?

*A.* The material is too hard and brittle, it does not shrink away from the mold in such a manner as to form a perfect duplicate in every case, thereby causing great loss in the manufacture, and also would be affected by moisture because it has no ceresin.

*xQ.* 46. What is the object of adding carnauba wax to the material of this sample we have just spoken of?

*A.* It gives to it certain properties in shrinking, after filling the mold with the composition, which enables the record to come out from the mold in a more perfect condition than it does when carnauba is not added; also, it gives to the record so made a greater wearing capacity. That is, it will stand reproduction more times without showing wear than the composition wherein carnauba is not used. It makes a surface for the record which may not be harder, but is tougher than if carnauba is not used.

*xQ.* 47. You have named two *purposes*, can you name any other results that are brought about by adding carnauba wax to the metallic soap mixture referred to?

*A.* No, none that now occur to me.

*xQ.* 48. At the time when you add the carnauba wax, the temperature of the material is stated in your patent to be about 360 degrees F., and you say that the temperature is raised to about 450 degrees F.: suppose you maintain the former temperature, what would be the result?

*A.* The combination between the carnauba wax and the composition to which it is added would take place very much slower and imperfectly.

*xQ.* 49. That is, you add carnauba wax to the aluminum soap mixture and apply the additional heat, in order to break up the carnauba and cause its constituents to enter into new combinations; whereas if you do not apply the additional heat the same results would be accomplished by a longer treatment with the lower heat?

*A.* I would not consider that the carnauba is broken up by the process, but what takes place is that part of the carnauba, the myricyl alcohol in a free state combines with a part of the excess of stearic acid.

*xQ*. 50. Carnauba wax is not a definite chemical compound, but is a mixture of certain chemical compounds, one of which is free myricyl alcohol and another a compound of myricyl alcohol with cerotic acid? *A*. Yes.

*xQ*. 51. What is the minimum temperature necessary to enable the free myricyl alcohol to combine with the free stearic acid?

*A*. I do not know what would be the exact minimum temperature.

*xQ*. 52. Do you know whether 360 degrees would be sufficient provided, of course, the treatment were continued the proper time.

*A*. I do not think that the complete re-action would take place at that temperature, no matter how long it were continued.

*xQ*. 53. Did you never try the experiment?

*A*. I have tried the experiment mixing the carnauba and keeping the temperature at a low heat—around 300 to 320 degrees F. and found that the reactions did not take place at those temperatures and that the composition resulting was of quite a different nature from the same material heated up to the higher temperature, as stated in the patent.

*xQ*. 54. When the carnauba was added to the aluminum soap mixture, and the temperature was kept around 300 degrees F. was there produced any portion of the compound ethers referred to in the patent in suit?

*A*. I should say not, although I have never analyzed the particular composition that I referred to for compound ethers.

*xQ*. 55. The material produced by treating the mixture of the aluminum metallic soap and the carnauba wax to a temperature around 300 degrees differs in what respects from the material produced by the Aylsworth patent in suit?

*A*. It is harder, has more apparent contraction and does not mold so readily.

*xQ*. 56. What do you mean by more *apparent* contraction.

*A*. The shrinkage in one case appears to be more, because it shrinks away from the mold in which it is cast, quicker than it does in the other case.

*xQ*. 57. The composition which has not been subjected to the higher degree of heat will shrink away more quickly than the composition which has been subjected to the higher heat?

*A*. Yes.

*xQ*. 58. If we take the aluminum metallic soap, as prepared in the first part of your patent in suit, at a temperature a little above its melting point and add to it carnauba wax at a temperature a little above its melting point, how would the material thereby produced differ from the finished material of the Aylsworth patent in suit; that is, the two ingredients are melted and the heat maintained until they are thoroughly mixed?

*A.* The resulting material would shrink away from the mold more quickly in the case of the material formed at the low temperature, and cause a less perfect record to be manufactured. Also, the material would be harder and less tough, which would show its effect in the wear on reproducing the record a great number of times, and would not be so durable.

*xQ.* 59. Have you ever tried the experiment required of in the preceeding question? *A.* I have.

*xQ.* 60. After the carnauba wax has been added and the high temperature maintained as stated in your patent, you add ceresin; what is the object of this?

*A.* To temper the material and render it less affected by moisture.

*xQ.* 61. Does the ceresin affect the shrinkage characteristics of the material?

*A.* Somewhat, in the same manner as the carnauba, when superheated, by causing it to adhere to the mold for a longer time.

*xQ.* 62. If we take the aluminum metallic soap and add carnauba wax, but without sufficient heat and time to produce the compound ethers, and if we then add a larger proportion of ceresin than stated in your patent, would the result be to give a material which would have practically the same shrinkage peculiarities and hardness of the finished product of the patent in suit?

*A.* In its shrinkage properties, yes, but in its wearing properties, no.

*xQ.* 63. You have tried this experiment also, have you?

*A.* Yes.

*xQ.* 64. In lines 79–80 of page 2, the patent speaks of a very hard wax, *preferably* carnauba, and in lines 115-118 of the same page, it speaks of paraffine or ozocerite as equivalents for ceresin; as a matter of fact, which are used by complainant.

*A.* In practising the invention of the patent, I prefer to use carnauba. In practising the invention of the patent I prefer to use ceresin.

*xQ.* 65. Why should ceresin when used be "free from paraffine" (line 126 of page 2)?

*A.* Because of the difference in price between ceresin and paraffine. If we care to use paraffine, we can buy it separately at a much cheaper price than we can buy ceresin and we prefer to specify in the purchase of ceresin a material free from paraffine.

*xQ*. 66. I understand that the instructions are given in the patent purely on account of the price. But suppose ceresin not "free from paraffine" were employed, what difference, if any, would be in the result?

*A*. If paraffine were used, it would be noticeable in the percentages of records broken during manufacture. We have found this out by actual experience.

*xQ*. 67. Is this ceresin subjected to any chemical reaction or change, or does it simply enter into a physical mixture with the rest of the material?

*A*. There is no chemical re-action or change takes place between the ceresin and the other ingredients. It is simply a mixture or a solution of the ceresin in the other material.

*xQ*. 68. After adding the ceresin and the coloring matter you may add free stearic acid. Does any chemical change or re-action take place from this latter?

*A*. There may be a chemical change take place, but the reason for the addition of the stearic acid is to regulate the congealing point of the material, or to regulate the temperature at which the material will remain fluid.

*xQ*. 69. Do you know whether there is any chemical change or reaction, and if so, what is it?

*A*. I do not know if there is any change or reaction if stearic acid is added finally to regulate the congealing temperature. I do not know that there is any chemical action, but from the great change in the congealing point, produced by the addition of small percentages of stearic acid, I should conclude that there was some chemical change.

*xQ*. 70. What effect does this final addition of the free stearic acid have upon the shrinkage and other physical properties outside of the congealing point?

*A*. Within the limits of the amounts that we add in practice, there are practically no effects in the shrinkage, etc. The addition of stearic acid to bring down the congealing point is simply replacing that which evaporates during the manufacture of the composition.

*xQ*. 71. Do you mean that stearic is volatile inside of 450 degrees F.? *A*. Yes.

*xQ*. 72. In making your analysis of the Columbia composition, did you find any sodium oxide or any other sodium compound not in combination with stearic acid? *A*. No.

*xQ.* 73. Did you determine how much, if any, free stearic acid there existed in the Columbia composition, as distinguished from the stearic acid in combination with other bodies?

*A.* No, not directly. But by calculation, the percentage of stearic acid found would correspond to far more than enough to form a neutral compound with the amount of soda and alumina found, and from that I would infer that there was a large amount of stearic acid in the free state.

*xQ.* 74. Did you determine how much, if any, aluminum oxide there was not in combination with stearic acid?

*A.* There was no aluminum oxide not in combination with the stearic acid.

*xQ.* 75. Your analysis given in Question 8 shows a percentage of sodium oxide 3.8, and shows a percentage of aluminum oxide .7; what percentage of stearic acid would be exactly sufficient to be completely neutralized by them?

*A.* $Na_2O$ (Sodium Oxide) in Columbia Composition equals 3.8 per cent. $Al_2O_3$ (Aluminum oxide) in Columbia Composition is .7 or in metallic aluminum equals 0.371 per cent. 3.8 parts by weight of $Na_2O$ will combine with and exactly neutralize 53.03 parts pure stearic acid, the product being stearate of soda, $Na\ C_{18}\ H_{30}\text{-}O_2$. 0.371 Al or .7 $Al_2O_3$ will combine with and exactly neutralize 11.65 parts of pure stearic acid to form stearate of aluminum $Al\ 3\ (C_{18}\ H_{35}O_2)$. The actual amount of fatty acids combined with the soda and alumina would be slightly less than the amounts given as they are calculated from pure stearic. Palmitic being present in the stearic acid of commerce in a large percentage and it having a lower molecular weight than stearic and a smaller amount will neutralize 3.8 parts of $Na_2O$ and 0.7 parts of $Al_2O_3$.

*xQ.* 76. One of the items enumerated in your analysis, given in Question 8, is "ceresin, parafine, ozocerite, or a combination thereof * * * * 14.3"; did you determine independently which of these were found and in what amounts?

*A.* No, I determined them as hydro-carbons which might include all of them. The method of separating the material would so change its color and appearance as to make its positive identity uncertain. The material which I actually separated from the Columbia composition appeared to be a mixture of paraffine and ceresin, but if ozocerite has been used, it could not have been separated, as such, because the operation of separating would refine the paraffine and ozocerite and there would have been obtained from it a material more closely resembling ceresin which is a refined form of ozocerite.

*xQ.* 77. What is the formula of carbonate of soda?

*A.* $Na_2, CO_3, 10(H_2O)$. This is the formula of the particular carbonate of soda referred to in the Aylsworth patent in suit.

*xQ.* 78. What is he formula for caustic soda? *A.* Na OH.

*xQ.* 79. Under the stipulation that sodium carbonate had been employed in making the Columbia composition, what became of the C.? *A.* It would go off as carbonic acid gas $CO_2$.

*xQ.* 80. And the same would happen to the H of the caustic soda?

*A.* The same would happen to the OH of the caustic soda in the following manner:

Two molecules of caustic soda enter in the reaction. After the re-action, the two atoms of Na and one atom of oxygen remain, and two atoms of H and one atom of oxygen escape as water.

*xQ.* 81. In what form did you separate the carnauba wax referred to in answer of Question 28?

*A.* In the form of myricyl alcohol and cerotic acid, two separate bodies which were separated and identified.

*xQ.* 82. You took no heed of the other ingredients of carnauba wax?

*A.* No, as these ingredients did not amount to over five per cent. of the carnauba wax it would be very difficult to separate and identify them without operating on a very much larger amount of material than I started with.

RE-DIRECT EXAMINATION, by Mr. DYER:

*R-dQ.* 83. I understood you to say that commercial stearic acid is always found combined with a considerable proportion of palmitic acid? *A.* Yes.

*R-dQ.* 84. In what respects does palmitic acid differ from stearic acid?

*A.* In its physical properties and chemical constitutions it is closely allied to stearic acid, the chief difference being the addition of a few degrees in the melting point in favor of stearic. acid. Palmitic acid is a few degrees lower in melting point.

*R-dQ.* 85. In the actual composition, does the palmitic acid enter into chemical combination with the soda and aluminum, as is the case with stearic acid? *A.* Yes.

*R-dQ.* 86. What does it form?

*A.* It forms a palmitate of soda and palmitate of alumina, which are undistinguishable from the corresponding compounds of stearic acid.

J. W. AYLSWORTH.

Sworn to before me and subscribed this twenty-sixth day of July, 1905.

HENRY D. OLIPHANT,
*Examiner.*

WEST ORANGE, NEW JERSEY, July 27th, 1905.

Met pursuant to adjournment.

Parties present as before.

ARTHUR S. BROWNE, being called as a witness on behalf of complainant, having been first duly sworn, on oath testifies as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. Give your name, age, residence and occupation?

*A.* Arthur S. Browne, age 44, Washington, D. C., Patent solicitor and expert.

*Q.* 2. What experience have you had qualifying you to testify as an expert in reference to patents for inventions, and particularly in the phonographic art?

*A.* I was graduated rom Darmouth College, Hanover, N. H., in 1881, and in the following year I entered my present profession in which I have since been actively and continuously engaged. I have prepared and prosecuted many hundreds of applications for patents; and I have made numerous investigations into the literature of various arts for the purpose of giving opinions concerning the novelty of inventions, and the scope, validity and infringement of patents. I have frequently visited workshops and factories for practical information. I have frequently testified as an expert witness in patent suits, having testified in nearly two hundred such suits. I have been familiar with the phonographic art for about fifteen years, and I have testified in a number of suits in which phonographic patents were in suit.

*Q.* 3. Have you read and are you familiar with the Aylsworth patent in suit, No. 782,375, dated February 14th, 1905? *A.* Yes.

*Q.* 4. Please consider this patent and state what you find to be the composition described and shown therein, and particularly as set forth in claims 1 to 10 inclusive, and claims 12, 14, 16, 18, 19, 20 and 22.

*A.* The Aylsworth patent in suit relates to an improved composition employed in making duplicate phonograph records. The specification states at the outset that the invention "relates to a new composition adapted particularly for making duplicate phonograph records obtained by any suitable process from a matrix or mold; but the composition has been gotten up especially for making duplicate phonograph records obtained by the process described in patent to Miller & Aylsworth, No. 683,605, dated October 1, 1901, and wherein a suitable mold carrying on its bore the negative representation of the record to be duplicated is immersed in a molten wax-like coaguable material, which forms a coagulated layer of the desired thickness on the bore of the mold, after which the material is reamed internally while warm and the resulting duplicate removed by shrinking diametrically, and removing the same longitudinally from the mold, its end being finally finished."

In the manufacture of duplicate phonographic records, the artist in the case of a song, sings in the vicinity of a song recording machine, the action of which is (in the case of recording machines like those of the Edison Company) to cut a shallow spiral groove in the periphery of a cylinder composed of a suitable wax-like material, the sinuosities and irregularities of the sound-groove conforming to the character of the sounds of the singer. The material of which this recording cylinder is made has to be such that it may be readily cut by the action of the cutting tool with which the sound-recording machine is equipped, and as a result, it is not susceptible of reproducing the song for a large number of repetitions. Moreover, it is important that a large number of duplicates should be made. The artist may be a high priced singer employed for the purpose, and, obviously, the business of selling records for the use of the public requires that the duplicates should be made in large numbers in an economical manner. In accordance with the Miller and Aylsworth patent of October 1, 1901, referred to in the patent in suit, a metal matrix or mold formed by a process of electro-plating is made from the original sound-cylinder made when the artist is singing. This matrix or mold is a hollow cylinder having on its interior surface a negative representation of the original sound record, that is to say, where the original sound record has a groove the matrix or mold has an interially projecting rib. As stated in the extract from the patent in suit just quoted, the new composition is particularly adapted for making duplicate phonographic records from such a matrix or mold by any suitable process, but especially refers to the process set forth in the said Miller and Aylsworth patent. In accordance with that patent, the composition for the duplicate records is melted and is introduced into the interior of the matrix or mold. The composition is, in effect, cast as a hollow cylinder within the matrix or mold. The composition flows on to the interior surface of the mold conforming to the irregular surface, the irregularities representing sound waves. After the cast is made, the melted material within the matrix or mold is permitted to chill, and, in chilling, it contracts sufficiently to clear the matrix or mold, so that the cast record can be removed end-wise from the cylindrical mold. The cast record, thus removed, is in the shape of a hollow cylinder, having on its exterior an irregular spiral groove exactly conforming to the sound groove formed in the exterior of the original record while the artist was singing. The duplicate record thus formed is then reamed out on its interior so as to form a series of inwardly projecting annular ribs adapted to fit upon the mandrel of a sound-reproducing machine. It is obvious that numerous castings can be made from the metallic matrix or mold, and, hence, that a large number of duplicate sound records to an indefinite extent can be made from a single matrix. In this way, many duplicates can be made from the original sound record at a moderate expense. The Aylsworth patent in suit sets forth in detail and *in extenso* the qualities and properties which the composition should have, which is to be employed in making of such duplicate records. These characteristics are, first, those which adapt the composition to the casting or molding method, and, second, those which pertain to the completed sound record itself, as the instrumentality for use in the sound reproducing machine. As stated more in detail in the specification, the composition should be very limpid when melted; should involve no decomposition products, which would form bubbles in the record surface; should gradually chill in becoming solid; should not be sticky or tenacious, so as to avoid sticking to the mold; should not shrink away from the mold until it has become quite hard in chilling; should shrink uniformly so as to avoid distortion of the sound record; and while still hot, it should be capable of being cleanly cut in the reaming of its interior so as to present a smooth clean surface at its interior to properly fit the mandrel of the reproducing machine. These are characteristics of the composition which pertain particularly to the casting metal of duplication. The characteristics which the specification sets forth as important in connection with the duplicate record as a sound producing device are that it should be of fine texture or grain, to avoid the production of extraneous sounds; it should be hard so as to avoid wear under the action of the sound reproducing machine; it should have a smooth and polished surface to aid in eliminating foreign noises during sound reproduction; it should be free from blow-holes at its surface, which would destroy its sound producing character; it should not be affected by moisture to facilitate its use in moist atmospheres; it should have so high a melting point as not to soften in hot weather; it should be of a dark color to facilitate inspections for imperfections; and it should be amorphous and non-crystaline so as to give a pure sound.

After stating these desirable attributes, the specification says;

> "The composition which I have invented and which will be herein described is one possessing these characteristics, and hence is especially adapted for use in this art." (Page 2, lines 5-8).

The specification then sets forth in great detail the ingredients employed and the steps carried out in making the composition. First the following ingredients are taken, namely—

Stearic acid,
Sodium carbonate,
Caustic soda,
Aluminium,

These ingredients are treated in the manner described in detail and as the result there is formed a metallic soap mixture containing stearate of soda, and stearate of alumina, these two stearates being specified in the patent drawing.

The next ingredient employed is "a very hard wax, preferably carnauba" (page 2, line 80). The carnauba wax is added in a stated quantity to the molten metallic soap mixture and is subjected to heat, the specification saying:—

> "When the carnauba wax is added to the soap mixture, the temperature of the mass is raised to about 450 degrees F. and maintained until all foaming ceases, which usually takes about five hours. By thus subjecting the mixture to a relatively high heat a combination is effected between the alcohols of the carnauba wax and the excessive stearic acid present in the metallic soap composition, forming a hard wax-like compound ether, which gives to the composition many of its desirable characteristics." (Page 2, lines 90-100).

Ceresin is then added for the purpose of making the composition non-hygroscopic and less brittle than it otherwise would be, and a dark pigment such as lamp black is then added to give the composition the desired black color.

The specification states that instead of ceresin "other hydrocarbon waxes may be employed, such as paraffine or ozocerite" (page 2, line 117) and that, although carnauba wax is preferred, yet it is found "that bees' wax and Chinese wax and palm wax all contain alcohols somewhat similar to those of carnauba wax and by which substantially similar actions take place" and that these materials may be substituted "but always at a sacrifice in the desirable condition of the resulting product." (Pages 3, lines 31-39.

It is also stated that when the composition is being used in making castings in accordance with the Miller and Aylsworth patent, No. 683,615, that the congealing point of the mixture may be adjusted to the proper temperature by the addition of stearic acid.

The composition which is thus produced comprises the metallic soap mixture (made from the stearic acid, aluminum, sodium carbonate and caustic soda), a hard wax such as carnauba wax, a non-hygroscopic ingredient, such as ceresin, and a black pigment such as lamp black. The composition results from the mixture of these materials. As stated in the specification, the employment of these ingredients results in the presence in the composition of a wax-like compound ether, due to the presence of free stearic acid in the metallic soap composition, and the alcohols of the carnauba wax.

The various claims of the patent to which the question directs my attention recite these various ingredients in different ways.

*Q.* 5. Are you familiar with the testimony of Mr. Aylsworth already taken in this case, with the several exhibits referred to and with the admission of defendant's counsel as to the composition used by defendant, and the process of making the same?

*A.* Yes.

*Q.* 6. Please make a comparison between defendant's composition as described and shown in this testimony and these exhibits, and in the admission of defendant's counsel with the composition described and shown in the patent in suit, and particularly as set forth in claims 1 to 10 inclusive, and claims 12, 14, 16, 18, 19, 20 and 22, and state the results of such comparison?

*A.* A side by side comparison between complainant's Exhibit, Aylsworth patent record, made in accordance with the patent in suit, and "Complainant's Exhibit, Columbia Commercial Records," shows that they are substantially alike in appearance and in general physical characteristics.

The evidence of Mr. Aylsworth and the admission on behalf of the defendant show that in the manufacture of defendant's composition the same ingredients are employed, which are set forth in the Aylsworth patent in suit, and that the defendant's composition and that of the patent contain the same elements.

The admission of the defendant shows that a metallic soap mixture is first made by the use of stearic acid, caustic soda lye, carbonate of soda, and metallic aluminium, or aluminium hydrate. The admission further states that after a saponification has taken place, the composition is completed by the addition of ceresin, carnauba and a black coloring substance. In addition Mr. Aylsworth states that in the final composition of the defendant, a wax-like compound ether is present, due to the employment of carnauba wax and stearic acid. Also, Mr. Aylsworth finds in the manipulation of defendant's composition that it possesses all of the characteristics in the casting or molding process of making duplicate sound records, and in use as a sound-reproducing medium, which the patent in suit states pertain to the patented composition. I find, therefore, that defendant's composition contains and embodies the subject matter of the several claims of the Aylsworth patent in suit which are mentioned in the question.

Claim 1 is as follows:

> "1. A composition for phonograph recording surfaces, comprising a metallic soap and a hard wax added thereto, substantially as set forth."

Defendant's composition is that which results from the use of these specified ingredients, defendant using in the manufacture of its composition a metallic soap resulting from the employment of stearic acid, caustic soda lye, carbonate of soda, and metallic aluminium or aluminium hydrate; and as a hard wax defendant employs carnauba wax. Therefore, defendant's composition is that specified in claim 1 of the Alysworth patent.

Claim 2 is the same as claim 1, except that it specifies carnauba wax instead of referring to a "hard wax" as does claim 1. Carnauba wax is used by the defendant in making its composition, and hence, defendant's composition is that specified in claim 2.

Claim 3 is like claim 1 except that it also specifies the presence of "a non-hygroscopic ingredient" and in defendant's composition ceresin which is such an ingredient, is employed, and, consequently, defendant's composition is that specified in claim 3.

Claim 4 is like claim 3, except that it specifies "ceresin" as the particular non-hydroscopic ingredient, and it follows, that defendant's composition is that specified in claim 4.

Claim 5 is the same as claim 3, except that it specifies *carnauba* wax instead of a *hard* wax, and there is the same difference between claims 4 and 6, and, since carnauba wax is used in making defendant's composition it is the composition specified in claims 5 and 6.

Claim 7 is as follows:

> "7. A composition for phonograph recording surfaces, comprising a mixture of a metallic soap and a wax-like compound ether, substantially as set forth."

Defendant's composition has in it a wax-like compound ether, resulting from the employment of stearic acid and carnauba wax, and, is hence the composition specified in this claim.

Claim 8 is like claim 7, except that it also specifies a "non-hygroscopic ingredient," and claim 9 is like claim 7 except that it also specifies "ceresin" and, because defendant's composition also includes ceresin as a non-hygroscopic ingredient, it is the composition specified in claims 8 and 9.

Claims 10, 12, 14 and 16, are like claims 1, 2, 6 and 7 respectively, except that each specifies in addition a "black pigment," and because defendant's composition includes a black coloring substance employed to give to the finished product a uniform dark appearance, it is the composition specified in each of these claims 10, 12, 14 and 16.

The claims 18, 19 and 20 are like claims 5, 6 and 12 respectively except that each specifies "stearate of soda" instead of "a metallic soap." Defendant's composition includes a metallic soap comprising stearate of soda, due to the employment of the ingredients from which the metallic soap is made, and consequently is the composition specified in each of the claims, 18, 19 and 20.

Claim 22, is as follows:

> "22. A composition for phonograph record-surfaces, comprising a mixture of stearate of soda, stearate of alumina and carnauba wax, substantially as set forth."

The metallic soap of defendant's composition contains stearate of soda and stearate of alumina, due to the employment of stearic acid, caustic soda lye, carbonate of soda, and metallic aluminum or aluminum hydrate, and the saponifying process, and carnauba wax is also employed, and, therefore, defendant's composition is that specified in claim 22.

I find, therefore, that defendant's composition contains and embodies each of the claims of the Aylsworth patent which are specified in the question.

CROSS-EXAMINATION, by Mr. MASSIE:

*Q.* 7. Please look at claims 1, 3, 4 and 10; also claims 2, 5, 6, 12, 14, 18, 19, 20 and 22, and finally claims 7, 8, 9 and 16. Do you observe that the first group of claims speaks of "hard wax" where the second group names "carnauba wax" and the third group "wax-like compound ether? *A.* Yes.

*Q.* 8. Is every form or variety of carnauba wax "a hard wax" as you understand that term in this patent?

*A.* So far as I know to the contrary, it is.

*Q.* 9. Is there any "hard wax" as you understand that term in this patent, besides carnauba wax, and if so, please name other materials which you consider hard waxes for the purpose of the patent?

*A.* This specification states that bees' wax, Chinese wax and palm wax all contain alcohols, somewhat similar to those of carnauba wax, and that these materials may be substituted for the carnauba wax "but always at a sacrifice in the desirable conditions of the resulting products." I understand, therefore, that bees' wax, Chinese wax and palm wax, are to be broadly considered as hard waxes, but are inferior to carnauba wax as far as the production of sound records is concerned. I have no information on this subject other than what is contained in the paragraph of the specification to which I here refer.

*Q.*10. Do you consider bees' wax, a *hard* wax; and if so, please name what you regard as soft waxes?

*A.* I have had no experience in the employment of bees' wax in the making of sound records, or any knowledge of its employment in connection with duplicate records, and consequently, do not know whether it is a hard wax for this purpose. Nor do I know what would be a soft wax for the purpose.

*Q.* 11. For any other purpose than "this purpose," if you do not regard bees' wax, as a soft wax, what waxes are soft, if any?

*A.* I do not know.

*Q.* 12. Is any and every "wax-like compound ether" always a *hard wax*? *A.* I do not know.

*Q.*13. Are there any "hard waxes" besides "wax-like compound ethers"? *A.* I do not know.

*Q.* 14. How about carnauba wax, and bees' wax for the purpose of this patent; is not each of these said to be a hard wax, and is either of them an ether?

*A.* I understand carnauba wax is a hard wax, and when it is treated with stearic acid in the manner specified in the Aylsworth patent, a wax-like compound ether is produced. I further understand from the patent that bees' wax to a certain extent acts like carnauba wax, and that when used in accordance with the patent in suit a wax-like compound ether is produced but less desirable for the purpose of duplicate sound record than when carnauba wax is employed.

*Q.* 15. Mr. Aylsworth has testified that carnauba wax to the extent of at least 95 per cent. consists of myricyl alcohol and cerotic acid; and that when it is added to stearic acid under continued high heat, its free alcohol unites with the stearic acid. Is what remains of the original carnauba wax, in your opinion, still "carnauba wax"? *A.* I do not know.

*Q.* 16. Please define the meaning of the following words that appear in the patent in suit, namely: "composition," "mixture," "compound ether," "metallic soap" and "hard wax"?

*A.* Composition means a complex body made of various ingredients.

Mixture means a number of ingredients mixed together.

Compound ether refers to the bodies which result from the action of stearic acid upon carnauba wax, under the condition stated in the patent.

Metallic soap refers to the material as it exists after the treatment of stearic acid, sodium carbonate, caustic soda, and metallic aluminium, in the manner stated in the patent, and it includes stearate of soda, and stearate of alumina.

Hard wax means a wax like carnauba wax, and less desirably and at a sacrifice of the desirable conditions of the resulting products, includes bees' wax, Chinese wax and Palm wax.

*Q.* 17. Was each one of these terms well understood among persons skilled in this art before the date of the patent in suit; and if so, what did each one of these terms mean in the general understanding of persons skilled in this art?

*A.* I believe that composition, mixture and metallic soap were well-known terms in the art before the date of the patent in suit, and that each was understood to mean what I have stated in my next preceding answer. Whether or not the terms "compound ether" and "hard wax" were used in the art prior to the date of the patent in suit, I do not know.

*Q.* 18. Then so far as you know, the term "hard wax" has a specialized meaning, new with the patent in suit? *A.* Yes.

*Q.* 19. And you understand that the patent in suit classes "bees' wax" as a hard wax; does this mean the ordinary bees' wax of commerce? *A.* I so understand.

*Q.* 20. And you know of no other wax-like compound ether except the body derived under heat from stearic acid and carnauba wax, or from stearic acid and ordinary bees' wax or the other waxes named in the last paragraph of the description of the patent in suit?

*A.* The only wax-like compound ether that I know of is that produced from stearic acid and carnauba wax when heated. I do not know that treatment of bees' wax, Chinese wax and Palm wax with stearic acid under heat produces a wax-like compound ether, though I judge that is the teaching of the patent.

*Q.* 21. What temperature should be applied to a mixture of stearic acid and bees' wax, in order to produce, if it does produce it, this wax-like compound ether? *A.* I do not know.

*Q.* 22. Have you carried out the directions of the patent in suit, and thereby produced the composition therein described? *A.* No.

*Q.* 23. Have you made molded sound records from such composition in accordance with the Miller and Aylsworth patent, referred to in your direct examination? *A.* No.

Adjourned until 10 o'clock Saturday morning, July 29th, 1905.

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WEST ORANGE, NEW JERSEY, July 29. 1905.

Met pursuant to adjournment at 10:30 A. M.

Parties present as before.

The cross-examination of the witness BROWNE is resumed by Mr. MASSIE.

*xQ.* 24. Do you understand that Aylsworth was the first to observe the desirability of the characteristics pointed out in the patent, line 38 of page 1, line 5 of page 2, and referred to in your answer to *Q.* 4?

*A.* As to some of them I should say not; as to others I do not know.

*xQ.* 25. Will you kindly indicate which of these characteristics you should say Mr. Aylsworth was not the first to observe the necessity for?

*A.* That the duplicate record should be of fine texture or grain, should have a very smooth and polished surface, should be free from air and gas bubbles, should be unaffected by moisture or summer heat, and should be amorphous and non-crystaline.

*xQ.* 26. So far as you know who was the first to observe that the material should be of excessively fine texture or grain, and what is your authority for your answer?

*A.* I do not know who was the first.

*xQ.* 27. What is there in the Aylsworth specification in suit that causes his composition to be of excessively fine texture or grain? That is, what material or materials, and what step or steps brings it about that the completed composition of the patent in suit is of excessively fine texture or grain?

*A.* The entire composition made in the manner described results in a product having the fine texture. Whether or not this can be attributed to any particular ingredient or any combination of the ingredients less than the whole I am unable to say.

*xQ.* 28. By "unable to say" you mean that you do not know?

*A.* Yes.

*xQ.* 30. Where and when, if you know, was the observation first made that this composition should have a very smooth and polished surface? *A.* I do not know.

*xQ.* 30. What is there in the Aylsworth specification that causes his composition to have a very smooth and polished surface?

*A.* The combination of ingredients set forth when treated in the manner set forth.

*xQ.* 31. Do you know whether or not the omission of any one of the ingredients or of any one of the steps set forth in the patent would still produce a composition having a very smooth and polished surface. *A.* No.

*xQ.* 32. Do you know when and where it was first observed that the composition should be free from air and gas bubbles?

*A.* No.

*xQ.* 33. What is there set forth in the Aylsworth patent that produces this result?

*A.* The combination of ingredients and the method set forth.

*xQ.* 34. Do you know whether if any of the ingredients and any of the steps should be omitted, the resulting composition would nevertheless be free from air and gas bubbles? *A.* No.

*xQ.* 35. When and where was it first observed that the composition should not be affected by moisture or summer heat?

*A.* I do not know.

*xQ.* 36. What is there set forth in the Aylsworth patent that causes the composition not to be affected by moisture or summer heat?

*A.* The immunity from deterioration by moisture is attributed by the specification to the presence of the ceresin. The high melting point which enables the composition to withstand ordinary atmospheric temperatures is the result of the completed product made from the specified ingredients in the manner set forth.

*xQ.* 37. And, as in former answers, you do not know whether this withstanding of the changes in atmospheric temperatures would be produced if any of the ingredients or steps should be omitted. *A.* No, I do not.

*xQ.* 38. What other effect, if any, is produced by the ceresin? *A.* I do not know.

*xQ.* 39. Where and when, if you know, was it first observed that the material for this purpose should be amorphous and non-crystaline? *A.* I do not know.

*xQ.* 40. What is there set forth in the patent in suit which renders this Aylsworth composition perfectly amorphous and non-crystaline?

*A.* The presence of the stated ingredients treated in the manner described.

*xQ.* 41. And as in previous answers, if any ingredient or steps would be omitted you do not know whether the composition would be perfectly amorphous and non-crystaline?

*A.* I do not.

*xQ.* 42. Do you know of any composition in this art outside of the composition produced from the stated ingredients treated in the manner described in the patent which is amorphous and non-crystaline? *A.* Yes.

*xQ.* 43. Please refer to the other characteristics set forth by the patent as desirable, and which are not enumerated in your answer to *xQ.* 25; what is there set forth in the patent in suit which renders the composition very limpid when in a molten or plastic state?

*A.* The stated ingredients treated in the manner set forth.

*xQ.* 44. What ingredients or what steps could be omitted without impairing the great limpidity of the composition "when in a molten or plastic state." *A.* I do not know.

*xQ.* 45. What material or composition have you ever seen that is very limpid when in a plastic state. *A.* I do not recall any.

*xQ.* 46. Are you prepared from your experience in this art to state that there is no such composition except the particular composition obtained from the stated ingredients treated in the manner set forth in this patent? *A.* No.

*xQ.* 47. Outside of the composition obtained from the ingredients stated in the patent when treated in the manner set forth in the patent, do you know of any composition in this art that is very limpid when in a molten state? *A.* No, I do not.

*xQ.* 48. What is there set forth in the patent that renders the Aylsworth composition "free of decomposition products"?

*A.* The stated ingredients treated in the manner described.

*xQ.* 49. Is that the most specific and definite answer you can make to the question? *A.* Yes.

*xQ*. 50. That is, you do not know whether any particular step may be omitted, and nevertheless the resulting composition would be free from decomposition products? *A*. No.

*xQ*. 51. When and where was it first observed that such a composition would be very hard when set? *A*. I do not know.

*xQ*. 52. Do you know whether or not the necessity for this characteristic was observed by any one before the date of the patent in suit? *A*. No.

*xQ*. 53. What is there set forth in the patent that causes the composition to be very hard when set.

*A*. The stated ingredients prepared in the manner set forth.

*xQ*. 54. And if any ingredient or step should be omitted, would the composition nevertheless be very hard when set?

*A*. I do not know.

*xQ*. 55. What is there set forth in the patent that produces the characteristic recited in line 55 *et seq.* of the patent in suit?

*A*. The stated ingredients treated in the manner set forth.

*xQ*. 56. Do you know whether ingredients or any steps could be omitted and nevertheless the composition would have the characteristic inquired of? *A*. No.

*xQ*. 57. Have you sufficient experience in this art to point out any particular step which pre-eminently and especially contributes to the characteristic inquired of? *A*. No.

*xQ*. 58. What is there set forth in the patent that renders the composition not sticky or tenacious?

*A*. The stated ingredients treated in the manner set forth.

*xQ*. 59. And is there any ingredient and any step that could be omitted and the composition would nevertheless be not sticky or tenacious? *A*. I do not know.

*xQ*. 60. Have you sufficient experience in this art to know of any material or composition, except that obtained from the stated ingredients treated in the manner set forth in the patent, which is not sticky or tenacious? *A*. No.

*xQ*. 61. What is there set forth in the patent that renders the composition capable of shrinking away from the mold when quite hard by a reduction in its temperature?

*A*. The stated ingredients treated in the manner set forth.

*xQ*. 62. And what ingredient or step could be omitted therefrom without impairing or affecting the characteristic inquired of- *A*. I do not know.

*xQ*. 63. Is your experience in this art sufficient to enable you to know of any other composition that is capable of shrinking away in the manner inquired of? *A*. No.

*xQ.* 64. What is there set forth in the patent that produces the characteristic recited in lines 80-82 of page 1?

*A.* The stated ingredients treated in the manner set forth.

*xQ.* 65. What ingredient or step could be omitted without impairing this characteristic? *A.* I do not know.

*xQ.* 66. Does your experience in this art enable you to name any other composition that has this characteristic? *A.* No.

*xQ.* 67. What is there set forth in the patent that produces the characteristic named in lines 86-90 of page 1?

*A.* The stated ingredients treated in the manner set forth.

*xQ.* 68. Can any ingredient or step be omitted without impairing this characteristic? *A.* I do not know.

*xQ.* 69. Is your experience in this art sufficient to enable you to name any other composition that has this characteristic?

*A.* No.

*xQ.* 70. What is there set forth in the patent that produces the characteristic set forth in lines 90–91 of page 1?

*A.* Black pigment.

*xQ.* 71. Do you know it to be a fact that the addition of pigment for the purpose of changing the color of an article is an obvious expedient?

*A.* That would depend upon circumstances. In some cases it might be and others not.

*xQ.* 72. Does the black pigment when employed in the manner stated in the patent have any effect except to produce a change in color.

*A.* I understand that to be the only purpose of the lamp black or pigment. Whether or not its presence has any effect on the other stated characteristics I do not know.

*xQ.* 73. Is there any step or ingredient set out in the patent that could be omitted, and yet, enable us to obtain a composition "of a very dark color"? *A.* I do not know.

*xQ.* 74. Suppose we have prepared the aluminum soap mixture as set forth down through lines 76–7 of page 2; and suppose we then add the specified quantity of carnauba wax, but without raising the temperature of the mixture as set out in the patent; and suppose we then finally add the specified quantity of ceresin and then follow out the remaining instruction. What composition would thereby be produced; and in what respects, if at all, would it differ from what you regard as the completed product of the patent?

*A.* I do not know what composition would be produced under the conditions stated in the question.

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*xQ.* 75. Do you know whether or not the addition of the carnauba wax to the aluminum soap mixture, but without the increased temperature, would result in the production of the compound ether, or of *any* compound ether? *A.* I do not.

*xQ.* 76. Please assume, if you can, that we have added the carnauba wax without increasing the temperature, that the compound ether has not been produced, but that we then carry out the remaining instructions of the patent; would the composition thus obtained be correctly described by the language of what I specified in *xQ.* 7 as the "first group"? *A.* I do not know.

*xQ.* 77. Would such composition be correctly defined as what in *xQ.* 7 I call the "second group"? *A.* I do not know.

*xQ.* 78. Would such composition be correctly defined by the language of what I have said in *xQ.* 7 the "third group"?

*A.* No.

*xQ.* 79. Suppose after obtaining the aluminum soap mixture we desire to employ ordinary bees' wax instead of carnauba wax; about what amount of bees' wax should we take, and about what time-temperature should we employ? *A.* I do not know.

*xQ.* 80. Suppose we should by some chance take the right quantity of bees' wax and apply sufficient time-temperature to obtain the compound ether, and should then carry out the remaining directions of the patent; would this composition be correctly described by the language of the first group" of claims?

*A.* That is my understanding.

*xQ.* 81. Would this composition be correctly described by the language of the "second group"; also, of the "third group"?

*A.* No, as to the second group. I understand that the patent states that if bees' wax is employed a wax-like compound ether is produced, and under this understanding such a composition would contain the subject matter of the third group of claims.

*xQ.* 82. Then if a composition is found not to contain *carnauba wax*, it is not correctly described by the language of claims 2, 5, 6, 12, 14, 18, 19, 20 and 22?

*A.* If no carnauba wax has been used in the production of the composition, it would not contain or embody the subject matter of the stated claims.

*xQ.* 83. Please examine the language found in lines 46–49, page 3; and state whether or not in your opinion this language sets forth a composition of matter? *A.* Yes.

*xQ.* 84. Do you understand from the language in the patent referred to in my question that the composition matter therein set forth must contain carnauba wax?

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*A*. Yes, or the products resulting from its employment.

*xQ*. 85. I call your attention to the words "added thereto" line 48 of page 3; what is the meaning of these words in this connection?

*A*. That in the manufacture of the composition the carnauba wax has been added to the metallic soap.

*xQ*. 86. Do you understand that the product is defined by the method employed in making it?

*A*. The patent in suit describes the product in connection with its mode of manufacture and the method carried out is of assistance in defining and identifying the product.

*xQ*. 87. Do you regard the language of claim 5 of the patent as setting forth a composition of matter? *A*. Yes.

*xQ*. 88. Do you understand that a composition must contain carnauba wax in the form of carnauba wax in order to be correctly described by claim 5? *A*. No.

*xQ*. 89. What do you understand to be the meaning, or rather the force in this connection, of the word "mixture"?

*A*. That the composition results from the mixture of the specified ingredients.

*xQ*. 90. Then, a composition in the preparation of which carnauba wax had been employed, in admixture with a metallic soap and a non-hygroscopic ingredient, even though there remain no carnauba wax in the form of carnauba wax, is correctly described by the language in claim 5? *A*. Yes, that might be the case.

*xQ*. 91. Suppose we have obtained aluminum metallic soap as set out in the patent, and then add ordinary bees' wax, but without raising to a higher temperature than was already present in the mixture, do you know whether any compound ether would be produced? *A*. No.

*xQ*. 92. Suppose we have added bees' wax, but have not applied a time-temperature treatment sufficient to produce any "compound ether"; and suppose we then proceed to carry out the remaining instructions of the patent; would this composition be correctly described by the first group of claims which called for the presence of "a hard wax"? *A*. I do not know.

*xQ*. 93. Would the composition obtained as stated in my last question contain "a metallic soap"? *A*. Yes.

*xQ*. 94. Would it contain "a hard wax added thereto"? *A*. Yes.

*xQ*. 95. In what respect then, does the language of claim 1 fail to describe such composition correctly?

*A.* Claim 1 calls for a composition for phonographic purposes with the specified ingredients substantially as described. I do not know whether or not the suggested compound would be capable of use for phonographic purposes or whether it would possess in any useful degree any of the characteristics of the patented composition set forth in the patent.

*xQ.* 96. Can you name any reason or reasons which would cause you to doubt that the composition inquired of in *xQ.* 92 would be capable of use for phonographic purposes, or that it would not be correctly defined by the language of claim 5? *A.* No.

*xQ.* 97. What meaning is conveyed to you as an expert in this art by the word "comprising" as used in the claims of the patent in suit?

*A.* That the composition is made by the employment of the ingredients named.

*xQ.* 98. Is any and everything which has been made by the employment of two or more specified ingredients, correctly spoken of as "*comprising* those ingredients?" *A.* I do not know.

*xQ.* 99. Will you give some authority or illustration for your statement that where the composition is made by the employment of ingredients named, *that* composition may be regarded as "comprising" those ingredients whether or not the identity of those ingredients has been changed during the process?

*A.* I do not recall any other authority at the present moment than the patent in suit, and the only illustration that I can at present give is the patent in suit.

*xQ.* 100. Please define the best you can the meaning of the word "comprising"?

*A.* In defining this word I cannot do better than follow the standard authorities. There happens to be conveniently at hand "The Imperial Dictionary of the English Language," published in London by Blackie & Son in 1883. Under the word "comprise" this authority says "see comprehend, which is the same word under a different form." It also says under this same heading "to comprehend; to contain; to include; as, the German Empire *comprises* a number of separate States." It then gives several quotations from standard authors, and then gives as synonyms "to embrace, include, comprehend, contain, encircle, enclose, involve, imply."

Among these synonyms is "to involve" and I understand that this closely indicates the use of the word as employed in the patent in suit.

*xQ*. 101. Please refer to the word "involve" in the same dictionary, Vol. 2, and state which of the meanings there given seem to you the proper meaning of the word "comprise"?

*A*. Among the numerous definitions given to the word "involve" is "to include by rational or logical construction; to imply; to comprise; the logical consequence." This fairly indicates the word "comprising," as used in the patent in suit; that is to say, the composition is that which results as the consequence of the use of the specified ingredients.

*xQ*. 102. Among the synonyms named in your answer to *xQ*. 100 is the word "encircle"; if we substitute in the claims the word "encircling" where the word "comprising" now occurs, would the claims convey to you the same meaning which they now convey?

*A*. That would render the claims somewhat meaningless. I could not imagine the word being used. Nevertheless, had such a word been used I think that with the preceding description contained in the patent the inevitable conclusion would be that the claim writer was intending to identify the resulting composition.

*xQ*. 103. Another synonym named in that answer is "contained"; if in the claims we substitute the word "containing" would the claims convey to you the same meaning that they now convey? *A*. Yes.

*xQ*. 104. Will you please point out in what respects, if any, the use of the word "contained" would change the meaning to your understanding, of the claims?

*A*. I do not think the word "containing" would be as apt as the word selected by the claim writer, but, in view of the preceding description, I should not regard the meaning of the claim as materially modified.

Signature and certificate waived.

Upon request of complainant's counsel, it is stipulated by defendant that prior to the filing of the bill of complaint herein, defendant was duly notified by letter of the acts herein complained of as infringements, and requested to desist therefrom; and that defendant has since continued the same act.

Counsel for Complainant gives notice that his *prima facie* case is closed.

In the Circuit Court of the United States for the District of New Jersey.

| | |
|---|---|
| NEW JERSEY PATENT COMPANY<br>*vs.*<br>COLUMBIA PHONOGRAPH COMPANY, GENERAL. | In Equity, No. 12,<br>March Term,<br>Aylsworth Patent<br>No. 782,375. |

## Defendant's Proofs.

(*Filed March 5, 1907.*)

FACTORY OF THE AMERICAN GRAPHOPHONE COMPANY,
BRIDGEPORT, Conn., Dec. 6, 1906.

Testimony for final hearing taken on behalf defendant before W. R. MILLER, ESQ., a Notary Public, acting as Special Examiner by consent, under the Statutes and Rules of this Court.

Met pursuant to agreement.

Present—DELOS HOLDEN, Esq., for Complainant; C. A. L. MASSIE, Esq., for Defendant.

By agreement the following depositions are taken in the absence of Frank L. Dyer, Esq., of Counsel for Complainant, who reserves the right of objection and cross examination of the witnesses.

Thereupon THOMAS H. MACDONALD, a witness produced by complainant, having been duly sworn, testifies as follows:

By Mr. MASSIE:

*Q.* 1. Please state your name, age, residence, and occupation?

*A.* Thomas H. MacDonald; age, 47; residence, Bridgeport, Connecticut; occupation, Manager of the American Graphophone Company's Factory.

*Q.* 2. How long have you been Manager of the factory?

*A.* Fifteen years.

*Q.* 3. Are you familiar with the compositions and processes for cylinder sound-records and blanks as employed by the American Graphophone Co. during that period? *A.* I am.

*Q.* 4. During the period around 1898 and 1902, speaking generally, in what manner were sound records for the market made?

*A.* By mechanical duplication.

*Q.* 5. Have you a patent for a mechanical duplicating apparatus? *A.* I have. No. 559,806, May 12, 1896.

*Q.* 6. In what manner are cylindrical records for the market now made? *A.* By molding.

*Q.* 7. Have you any patents relating to the molding of sound records?

*A.* I have. Reissue No. 12,095 and reissue No. 12,096, both dated March 10, 1903.

*Q.* 8. How do the present molded sound records compare in hardness or durability with the mechanically duplicated records formerly put out by you?

*A.* They are much harder and consequently more durable.

*Q.* 9. Why are the molded records given greater hardness; and why were the mechanical duplicated records not made equally hard?

*A.* It was necessary to cut the records in the mechanical duplication, so a very hard substance was not suitable. In the molded record, there is no cutting done and it is practicable to make the material much harder and so more durable.

*Q.* 10. Are you the Thomas H. MacDonald named in U. S. Letters Patent No. 606,725 of July 5, 1898 and No. 626,709, of June 13, 1899? *A.* I am.

*Q.* 11. At the dates of these patents, 1898-9, was the composition and the manner of procedure, including temperatures, set forth in these patents employed by you for the regular cylinder product of The Graphophone Co.? *A.* They were.

*Q.* 12. This composition is commonly known as the "MacDonald Composition," is it not? *A.* It is.

*Q.* 13. During your connection with the Graphophone Factory have you ever had occasion to harden the cylinder compositions; and, if so, how was it done?

*A.* I have done so. In 1898 when we were using the original "masters" in our duplicating machines, we found they wore out in from twenty or thirty reproductions. In experiments directed to prolong the life of these masters, I used carnauba wax for the purpose of hardening the original master record. This, for the purpose of making it wear longer under the reproducing stylus in the duplicating-machines.

*Q.* 14. How long have you been familiar with the fact that carnauba wax has the property or result of hardening these wax-compositions? *A.* About sixteen years.

*Q.* 15. Is that information general among persons in the talking machine art? *A.* I think it is.

*Q.* 16. What can you say as to the presence in stock, in the Factory of the American Graphophone Co. during past years, of carnauba wax?

*A.* There was a substantial quantity of the wax in the laboratory of the company when I took charge of it in 1891. I found it mentioned in two patents of the company, which had been granted to Bell and Tainter, some four or five years before, and the workmen who were in the laboratory and wax rooms of this compañy were all familiar with its use in hardening the cylinder wax used for making Graphophone cylinders.

*Q.* 17. Of what composition are the present molded sound records made? I refer, of course, to those made by the Graphophone Co.?

*A.* They are made under the formula of the Macdonald patent 606,725 above mentioned, with the addition of a substantial quantity of carnauba wax for the purpose of hardening the compound, and of a coloring pigment.

*Q.* 18. How long have you been familiar with the fact that if you add a coloring pigment, say black, to a composition, it will darken the composition?

*A.* As long as I have known anything about the composition.

*Q.* 19. About what time were defendant's molded cylinder records put on the market in hardened condition in large quantities? *A.* Early in 1903.

*Q.* 20. Have you used continuously down to the present substantially the same composition in making these hard molded cylinder records? *A.* I have.

*Q.* 21. Please state how you came to make these molded records harder?

*A.* The demand for a longer life in the product which came to me from the selling end of the business. This indicated that we must make them harder. It was well known to all of us that if we did add carnauba wax it would make them harder, and as the demand seemed to warrant the additional expense, we did so, and have continued to do so ever since.

*Q.* 22. I understand that you have made molded records from the "Macdonald composition," set forth in your patent No. 606,725 aforesaid, and also from the same composition plus a substantial amount of carnauba wax. Please look at paragraph in the Aylesworth patent in suit, beginning at line 38 of page 1 thereof. In respect to limpidity, freedom from "decomposition products," fineness of texture, freedom from crystallization, smoothness of surface, shrinkage, capacity of being reamed while still hot, and in fine all the qualities named by Mr. Aylesworth in the paragraph pointed out, except hardness or durability,—How did the ordinary Macdonald composition compare with the same composition plus carnauba?

*A.* It compared very favorably. In fact, as far as I know or we could see, there is no difference whatever.

*Q.* 23. In your opinion, which, if any, of all the qualities or properties named in that third paragraph of the patent in suit is due to the presence of carnauba?

*A.* The only thing in this paragraph due to the presence of carnauba is that described in line 53 and 55, namely, "it should be very hard when set, so as to reduce wear as much as possible due to the tracking of the reproducer."

*Q.* 24. You have stated (*Q.* 17) that you add "a substantial quantity" of the carnauba. Complainant's witness Mr. Aylsworth has testified (*Q.* 8) that the Columbia molded records contain 7.8 per cent of carnauba wax. Is he correct?

*A.* He is not. It is considerably more than that.

*Q.* 25. I understand you to say that defendant's product, the Columbia molded records, contain considerably more than 7.8 per cent. of carnauba. Am I correct?

*A.* You are correct. We use nearly double that amount.

*Q.* 26. In making up the composition, is there any difficulty encountered in adding or introducing the carnauba wax?

*A.* We have never experienced any difficulty.

*Q.* 27. To what do you attribute the limpidity of the composition as employed by you in molding sound records?

*A.* The heat in melting it.

*Q.* 28. You employ about the temperature named in the Macdonald patnet No. 626,709 aforesaid and in the two Macdonald reissue patents above named? *A.* We do.

*Q.* 29. Is "aluminic hydrate" named in formula A of Macdonald patent No. 606,725 the same as "hydrate of aluminum?"

*A.* It is the same.

*Q.* 30. In the same patent, Formula A names aluminic hydrate while Formula B calls for powdered aluminum. Is one just as good as the other for this purpose; that is, have you ever observed any difference in the behavior of the two compositions?

*A.* I have not. The compositions are the same, and behave the same.

Deposition closed subject to cross examination.

BRIDGEPORT, Conn.,
Dec. 19, 1906.

Met pursuant to agreement.

Present—FRANK L. DYER, ESQ., for Complainant; C. A. L. MASSIE, ESQ., for Defendant.

The deposition of THOMAS H. MACDONALD, which was suspended to take the testimony of the other Bridgeport witnesses, is here resumed.

By Mr. MASSIE:

*Q.* 31. Have you ever formed a cylinder composition by adding bees wax to the Macdonald composition of the Macdonald patent No. 606,725 of July 5, 1898; and if so, wherein did such composition differ from the aforesaid Macdonald composition of your 1898 patent?

*A.* It made the composition softer. It gave it a sticky, resinous condition.

CROSS EXAMINATION, by Mr. DYER.

*xQ.* 32. Is it not a fact that when the American Graphophone Co. first made molded records they advertised them as: "Columbia Records can be shaved, if desired, and the blank recorded upon. This is true of no other New record upon the market."

*A.* I do not have anything to do with the advertising, neither does the American Graphophone Co. The American Graphophone Co. turns its product over to the Columbia Phonograph Co., which does all the advertising and all the selling.

*xQ.* 33. Is it not a fact that when molded records were first put on the market by the Columbia Phonograph Co. those records were advertised as having the peculiarity recited in my previous question?

*A.* My impression is that they did so advertise, though I do not recollect that I actually saw these advertisements.

*xQ.* 34. It was a fact, however, was it not, that the molded records first put out by the Columbia Phonograph Co. were capable of being shaved off.

*A.* They could be more easily shaved than the present record as they were softer. It is perfectly practicable, however, to shave the present record and make a new record upon it. It requires a little more care in the operation, that is all.

*xQ.* 35. The molded records that were first put out by the Columbia Co. were made of the ordinary blank composition, were they not?

*A.* They were.

*xQ*. 36. Can you produce one of these first molded records?

*A*. I am not sure in regard to that, though I think it may be possible to find them. I will try to find them, however.

*xQ*. 37. How old is the art of molding records, in a commercial sense; it is comparatively recent art, is it not?

*A*. It is comparatively recent as far as I know.

*xQ*. 38. It is a fact, is it not, that this art was commercially developed at very nearly the same time by the American Graphophone Co. and the National Phonograph Co. some time early in 1902?

*A*. I had developed the art for the American Graphophone Co. a year earlier than that.

*xQ*. 39. But as I understand the situation, commercial molded records as such were not marketed until early in 1902. Is that correct?

*A*. The first molded record made by the American Graphophone Co. under my processes were used for masters for duplicating purposes. Many of these masters were sold, but not as molded records, prior to the time you mention. The molded records were placed on the market and announced as molded records somewhere about the time you mention.

*xQ*. 40. And these Columbia Molded records which you say were made of the ordinary blank composition were, as I remember them, of a brownish color and were formed on their interior with a more or less imperfectly defined spiral rib, made by casting the interior instead of by cutting it as is now done. Am I correct?

*A*. The interior of the record has always been cut ever since the records were first made. This is necessary, as it is impossible to cast the records sufficiently accurate to fit the mandrel. They were of a brownish color.

*xQ*. 41. You say that the records have always been cut on their interior. Is it not a fact that with the first brown molded records of the Columbia Co., the cutting was limited to the inner face of the spiral rib, while with the present molded records of the Columbia Co. the entire interior is finished by cutting?

*A*. That is right.

*xQ*. 42. The two patents referred to in answer to *Q*. 16 are No. 393,190, dated Nov. 20, 1898, to Tainter, describing a composition of bees wax and carnauba, and No. 421,450, dated Feb. 18, 1890, to Tainter, describing a composition of ozokerite and carnauba, are they not? *A*. They are.

*xQ*. 43. And in both of these compositions, as I understand your testimony, the carnauba was used to harden the relatively soft bees wax or ozokerite as the case might be? *A.* Yes.

*xQ.* 44. Would it be possible for you to produce one of the old Tainter blanks, making use of either one of these compositions?

*A.* I do not know whether I have any of these blanks in my possession, but will search for one.

*xQ.* 45. It is a fact, is it not, when the first Columbia molded records were put out they contained no coloring pigment?

*A.* It is.

*xQ.* 46. At that time, were not Edison records very much darker in color than the Columbia records?

*A.* I could not pass on that question now. I do not recollect.

*xQ.* 47. You are not able to say then that ever since Edison records were put on the market early in 1902 they have always been the same uniformly dark, almost black, in color?

*A.* I could not say as to that.

*xQ.* 48. When the change was made in the color, composition, physical construction, and method of manufacture of the Columbia records, do you recall the appearance and construction of the Edison records?

*A.* My impression is they were a dark, though I cannot state positively, color.

*xQ.* 49. You do not remember then that when the change was made in the Columbia records the effect was to produce a record very closely resembling the Edison record both in color and physical construction?

*A.* I do remember that the change was not made for any such purpose. The reason the records were made black, uniformly black, was to have them all alike. The material we used when we cook in iron pots has a tendency to grow darker with each re-heating. As a large amount of scrap is used, and as this amount varies under different conditions, the result was a varicolored product. This caused considerable confusion in the trade, some believing that the darker records were the best, others that the lighter shade were preferable. As the natural tendency of the manufacture was to grow darker, we decided to relieve that situation by making them all black, as black as we could, and thus eliminate all chance for dispute among the trade as to the merits of the darker shade as compared to the lighter.

*xQ.* 50. Whatever may have been the purpose of the change, the effect of the change was, however, to produce a record that very much more closely resembled the Edison record than the previous brown records that the Columbia Co. had put out. Is that true? *A.* It is.

*xQ.* 51. And the same is true, is it not, as to the change from the single spiral rib on the bore of the old brown records to the concentric ribs on the bore of the present Columbia records?

*A.* The change in this respect was made in the matter of economy. As to whether it resembled the Edison record at that time or not, I am not prepared to state positively, but my impression is that they had the same form of ring at that time.

*xQ.* 52. In answer to *Q.* 19 you state that defendant's molded cylinder records were put on the market early in 1903. I presume you have reference to the records made of the present composition, and not th old brown record.

*A.* I had reference to the molded record with the use of carnauba wax as a hardening mixture.

*xQ.* 53. Is not your date wrong, and was it not nearer August, 1903, that these records were put on the market?

*A.* My recollection is that it was in March or April of 1903.

*xQ.* 54. As I understand Mr. Farini's testimony, it is that carnauba wax was purchased in considerable quantities beginning some time in April, 1903. Do you recall whether the records were put on the market almost immediately after you began to use carnauba, or was it some months after?

*A.* My recollection is that the first substantial quantity of carnauba wax was purchased in March, 1903, and further that it was used in the records and immediately put upon the market. Just how quickly such a product as that would get into the hands of the trade, I could not say. It depends somewhat on the stock in the hands of the Columbia Phonograph Co. At that time, I think it was not very large.

*xQ.* 55. I have quite a distinct impression that the present Columbia records of a uniformly dark color were put upon the market about Aug. 1, 1903. If I am correct, would it be correct to say that between March, 1903, and August, 1903, you were experimenting to ascertain the sentiment of the trade regarding the color of the composition?

*A.* There is no connection between the use of coloring matter and the use of carnauba wax. I cannot now recall when the coloring matter was added. It may have been the time you say, August 1, 1903.

*xQ.* 56. Is it not a fact that the old brown Columbia records without carnauba were sold for fifty cents each and that when the present Columbia record with carnauba was introduced, the price was reduced to twenty-five cents each, or, at any rate, to a lower figure than fifty cents?

*A.* There was a reduction in price of the record by the Columbia Phonograph Co., but just when it took place or why it was made, I am not compentent to answer.

*xQ.* 57. You do not know then that the reduction in price was made concurrently with the use of carnauba. *A.* I do not.

*xQ.* 58. Referring to your answer to *Q.* 21, are you able to say what caused the demand for harder records?

*A.* There was no demand for harder records that I recollect. The demand as stated in my answer to that question was for a record that would not wear out so quickly. I was the one who made the determination that a harder record would tend to satisfy this demand.

*xQ.* 59. Do you know what caused this demand?

*A.* Yes. The users were dissatisfied that the records wore out so quickly.

*xQ.* 60. When this demand arose, it is a fact, is it not, that Edison records were longer lived than the Columbia records?

*A.* I cannot say that this is right.

*xQ.* 61. In answer to *Q.* 22 you institute a comparison between two compositions, as to their physical properties. How elaborate an examination of these compositions did you make before instituting that comparison?

*A.* The comparison was made by having had the mixtures prepared and then by comparing them as to limpidity which I interpret to be a state of being a liquid, that is, something that could be poured readily; second, testing them for what we call "bloom" which is a dimming of the surface; the fineness of texture, by visual examination of the fracture. The same process was pursued in determining whether there was crystallization present, also for the surface, shrinkage, reaming, etc. For hardness or durability tests were made by shaving them, recording upon them, and putting them through the wear test in the usual way.

*xQ.* 62. The wear tests then were made with original records and not molded records?

*A.* They were made with molded records.

*xQ.* 63. What would be the purpose of shaving and recording upon the blanks?

*A.* As I have been asked by my counsel to make specific tests to determine the point referred to in *Q.* 22, these tests I made in every way which occurred to me, and were as I have mentioned.

*xQ.* 64. As I understand it, except for determining the hardness and durability of the compositions, your tests were all purely visual or eye tests? *A.* They were.

*xQ.* 65. Would it be a fair statement to say that you use in your composition and have used therein since 1903, substantially 15 per cent. of carnauba, instead of 7.8 per cent. as determined by Mr. Aylsworth?

*A.* Since my answer to a question of this nature in the direct examination, my attention has been called to the fact that the percenages which we use and that Mr. Aylsworth uses are figured on different bases. In our formulas the percentage of each ingredient is figured on the quantity of stearic acid used, and the percentage of carnauba wax which we use in our compound is substantially 14 per cent. of the amount of stearic used. For that reason, I made the answer that I did.

*xQ.* 66. Then as I understand it you make use of substantially fourteen pounds of carnauba wax for each 100 pounds of stearic acid?

*A.* That is substantially correct.

*xQ.* 67. Can you give me the exact figure?

Question objected to as immaterial and as tending to disclose what may be a confidential matter.

*A.* The exact formula employs 250 pounds of stearic acid and 33½ pounds of carnauba wax when the stearic acid is of a certain grade. When the stearic acid shows a little softer test, we add a litle more carnauba.

*xQ.* 68. How high do you go with your carnauba?

*A.* As high as 36 pounds in 250 pounds of stearic, which is a trifle over 14%. The exact formula in use at the present is slightly under this, and about 33 pounds of carnauba wax to 250 pounds of stearic acid.

*xQ.* 69. In using canauba did you not observe that the foaming was very much greater than if not used?

*A.* I have not observed any difficulty on this point. I have not observed that the foaming was any greater.

*xQ.* 70. Is the wax composition made under your direction or observation?

*A.* It is made under my direction, but of course not under my immediate supervision, except at such times as I may go to that department. I will say that I did not, in the original experiment, notice any difficulties on this point, nor has my attention been called to it by any of the men engaged in making the mixtures.

*xQ.* 71. Did you ever observe or were you ever informed that a much longer time was required to foam off the composition when carnauba is used than when it is not used?

*A*. I have not observed it, nor have I been so informed.

*xQ*. 72. Did you ever manufacture or witness the manufacture of the old Tainter ozokerite carnauba composition?

*A*. I have made many mixtures of ozokerite and carnauba, but cannot recall now any instance where I used the exact proportions indicated in Mr. Tainter's patent.

*xQ*. 73. In experimenting with ozokerite carnauba compositions did you ever observe any excessive foaming?

*A*. All my experiments with ozokerite and carnauba are now pretty far back in history and without refreshing my mind by some other way, I could not recall the details of such experiments.

*xQ*. 74. In answer to *Q*. 27, you attribute the limpidity to the heat used. Is not the limpidity due to the composition rather than to the heat?

*A*. The limpidity is due to heat entirely, in all substances about which I know. There are different degrees of limpidity in different substances. The heat always produces limpidity as far as I know.

*xQ*. 75. Dealing with these compositions, if the heat is maintained long enough will not stearic acid be driven off and the product be made less limpid?

*A*. I think that would be the case though I have never carried it far enough to determine positively. In the practical use of the material, I have not encountered this difficulty.

*xQ*. 76. If asphalt or rubber or stearate of alumina is subjected to heat will it become limpid?

*A*. I have never tried the experiment.

*xQ*. 77. What is the temperature used in making defendant's composition?

*A*. About 450 degrees F. It is the final temperature reached and must be reached before the material is considered as *made* or ready for moulding.

*xQ*. 78. How long is the temperature maintained at 450 degrees F or in that neighborhood?

*A*. Two or three hours is sufficient, though in cases of necessity, we have used less time. We have also used a greater time.

*xQ*. 79. That is to say, you maintained the high temperature until foaming ceases however long that may take?

*A*. We do not begin the high temperature until the foaming has ceased. While the foaming is going on the temperature is about 212 degrees or about the boiling point of water.

*xQ*. 80. Am I correct in understanding that you maintain a temperature of 212 degrees or thereabouts until all foaming has ceased? and that you then slowly raise the temperature to 450 degrees or thereabouts and that during this rise of temperature no foaming takes place?

*A*. Substantially no foaming takes place in the rise of temperature.

*xQ*. 81. What do you mean by foaming?

*A*. I mean the same thing that is used by engineers when they speak of a boiler foaming. It is a condition when a large excess of bubbles will rise to the surface causing our pots to boil over, which is of course a dangerous condition.

*xQ*. 82. Do you make any distinction between foaming and the ebullition of gas or products of decomposition? *A*. I do.

*xQ*. 83. That being so, I will ask if, in making the composition, you observed any greater ebullition of gas when carnauba is used than when it is not used?

*A*. As I have previously stated, I do not recollect any difference in the behavior in the material if used with carnauba from that when carnauba is omitted.

*xQ*. 84. And this is true also of the time required to bring the composition to a state of quiescence?

*A*. As far as I remember, it is.

*xQ*. 85. After the foaming has ceased and you are then dealing with the question of the ebullition of the gas, how long do you maintain the composition at the high temperature? Until all the gas has been driven off?

*A*. I do not know without looking the matter up.

*xQ*. 86. When you made the change to carnauba, was there not also a demand for a record with a reamed interior like the Edison record?

*A*. I think not. I do not recollect that any demand came from the public or the trade for this reaming. It was, as I stated before, done solely as a matter of economy.

*xQ*. 87. And that was the reason why you changed your process when the composition was changed?

*A*. Which process do you refer to?

*xQ*. 88. I have reference to the process now used by defendant in which a series of molds is immersed beneath the surface of the very hot composition, after which the molds with their contents are removed, subjected to a cooling bath of water, and finally the effect of an air blast as disclosed in your patent No. 773,801 dated Nov. 1, 1904.

Question objected to as improper cross examination and as without any basis of fact in this suit.

*A.* It was done solely as a matter of economy to start with, but the process developed the values as indicated in said patent, all of which were duly protected by the patent mentioned.

Defendant's counsel gives notice that as to the foregoing answer, complainant makes the business his own. In order to explain the witness's answer, defendant's counsel offers the said patent in evidence as "Defendant's exhibit, Macdonald patent No. 773,801, Nov. 1, 1904."

*xQ.* 89. As I understand the process which you and Mr. Thornberry have referred to in your deposition and which is now and has been practiced by defendant since 1903, you first take commercial stearic acid and melt the same in a suitable containing vessel, is that correct? *A.* That is correct.

*xQ.* 90. What temperature do you use in melting the stearic acid?

*A.* We melt the stearic acid without regard to temperature. Care is taken not to use sufficient heat to either evaporate or ignite the material.

*xQ.* 91. In selecting the stearic acid, do you exercise care to obtain the substantially pure article?

*A.* We exercise great care in obtaining an article which our experiments have proven to be the best for our purpose, consistent with economy. As to whether this would be called pure stearic acid by a chemist, I am not prepared to say.

*xQ.* 92. Do you exercise care in obtaining the stearic acid substantially free from oleic? *A.* We do.

*xQ.* 93. Do you exercise care in obtaining the stearic acid substantially free from mineral acid?

*A.* Our tests, as I stated, are all practical. We do not make specific tests for anything of this kind. The actual composition is made from the shipments received when we have time to make them, but when business is pressing as it very often is we trust to fate and take the manufacturer's word that the article is the same as they have previously furnished.

*xQ.* 94. Speaking generally, however, I suppose there are many grades of stearic acid on the market that would be too impure. *A.* There are.

Recess.

*xQ.* 94a. As I understand it also, you make a solution of carbonate of soda and caustic soda in which you dissolve metallic aluminum or aluminum hydrate so as to form aluminate of soda. Is that correct?

*A*. That is not quite correct. Where we use hydrate we do not use anything except caustic soda for making the solution as specified in formula of the patent.

*xQ*. 95. You do in fact, use the hydrate as the source of alumina in your process? *A*. We do.

*xQ*. 96. Is the resulting composition in any way effected whether the hydrate or metallic aluminum is used?

*A*. That I am not prepared to answer.

*xQ*. 97. Do you entertain any doubt but that the same result would be secured were you to use the hydrate or the metallic form?

*A*. I have practically no experimental work in this department with reference to the use of aluminum in any form or its proportions when combined with caustic soda or stearic acid for about eight years and am therefore not prepared to give an opinion at this time on a question of this nature.

*xQ*. 98. With the samples that were made by Mr. Thornberry, No. 2 and No. 3 were made with aluminum hydrate and No. 5 and No. 6 were made with metallic aluminum. In your examination of these samples, did you observe any differences in the several compositions due to the particular source of alumina used? *A*. I do not recall that I did.

*xQ*. 99. Do you maintain that for the purpose of saponifying the stearic acid a solution of carbonate soda results in any different product than when a solution of caustic soda is used?

*A*. There is a doubt on that point. I mean as between the two formulas mentioned in my patent, and I am not prepared to state that one formula is better than the other.

*xQ*. 100. With the samples made by Mr. Thornberry No. 2 and No. 3 made use of a caustic solution, and No. 5 and No. 6 made use of a combined carbonate and caustic solution. Did you observe any differences between these compositions due to the particular form of alkali used?

*A*. I do not recall that I considered any of these points in connection with these samples.

*xQ*. 101. Having obtained your solution, is it your practice to filter it?

*A*. I am not prepared to answer that. I don't remember. My impression is that we do not filter unless the foreman is in doubt as to the purity of the material.

*xQ*. 102. After the solution is formed I understand that it is then added to the melted stearic acid? *A*. It is.

*xQ*. 103. Is it added rapidly or slowly?

*A*. It is added slowly.

*xQ*. 104. Why is the solution added slowly?

*A*. The solution consists principally of water. The melted stearic acid is above the boiling point of water. If it were added rapidly the escape of steam would cause mechanical difficulties in the manufacture in the way of overflowing, possibly a slight explosion of steam and a tendency to scatter the melted stearic acid about. These are all mechanical details with which the workmen are much more familiar than I am.

*xQ*. 105. During the addition of the solution to the melted stearic acid reactions take place as I understand it, resulting in the production of stearate of soda and stearate of aluminum. Is this your understanding?

*A*. I am not a sufficient chemist to go into details of this description.

*xQ*. 106. Have you sufficient chemical knowledge to say that the addition of the alkaline solution to the melted stearic acid results in the formation of a metallic soap?

*A*. I have. My understanding is that the product by such a combination is known as a "metallic soap." I am not clear, however, what is meant by metallic soap. As I understand it, every soap is a metallic soap. No soap can be formed without the union of salts of potash or the salts of sodium with some fat or oil. As both sodium and potassium are metals, I think every soap is a metallic soap. It strikes me that a better term for this would be a "double metallic soap."

*xQ*. 107. That is to say, as I understand you, a soda soap and an aluminum soap?

*A*. In this case, it seems to me that the expression "a double metallic soap" of sodium and aluminum would more clearly express what it actually is.

*xQ*. 108. Now, during the formation of this metallic soap or double metallic soap, that is to say, during the saponification or partial saponification of the stearic acid, is not a mass formed whose melting point gradually rises?

*A*. I do not understand that the melting point gradually rises. In the mixtures in question, those described in my patent, I do not consider the mixture formed until all the water has been expelled from the added solution. As soon as this is done, I am not aware that there is any change in the melting point of the material assuming that it were allowed to cool at the instant of completion of mixture.

*xQ.* 109. Do I understand that during the entire time the solution is being added to the stearic acid and the saponification is being effected the temperature is maintained at or near 212 degress F?

*A.* I do not recollect ever having made a record of the temperature at this time. Our practice is to add the solution as rapidly as we can, keeping the mixture as hot as possible to expedite the work. My belief is that the temperature of the mixture is not at this time much above 212 degrees which is the point of the escape of steam.

*xQ.* 110. Have you ever taken observations of the temperature of the mateirial during the addition of the solution?

*A.* I have taken very many of them at all stages of the work, but as it was at a time over eight years ago when it was done, my recollection of them is entirely too hazy to give any exact data as to exact figures and temperatures.

*xQ.* 111. At any rate, I suppose you apply sufficient heat to the material while the solution is being added to drive off the water freely? *A.* We do.

*xQ.* 112. Am I correct in understanding that after the partial saponification of the stearic acid has been effected you then add carnauba wax? *A.* We do.

*xQ.* 113. What is the temperature of the mass during the cooking thereof after the carnauba wax has been added?

*A.* I do not recall it. My memory on that point is that the mixture must be raised to a temperature of 450 to 475 degrees and maintained at that temperature for a definite time before the material is ready for use.

*xQ.* 114. And as I understand it this high temperature is maintained for from two to five hours depending on the circumstances?

*A.* I think that is correct.

*xQ.* 116. After the addition of the carnauba wax, did you ever observe any phenomenon from which you would conclude that a chemical reaction was taking place?

*A.* I have never made such observation.

*xQ.* 117. When is it your practice to add the hydro-carbon ingredient, such as paraffine. After the carnauba or before?

*A.* I do not recall that it makes any difference and as a matter of fact do not know whether the wax department are adding the hydro-carbon first or not.

RE-DIRECT EXAMINATION, by Mr. MASSIE:

*R-xQ.* 118. In answering *Q* 22, in which you compared the behavior of the Macdonald composition and of the same composi-

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tion with carnauba wax, was your information gained entirely from the tests made by Mr. Thornberry last August?

*A.* Partially from Mr. Thornberry's tests, partially from my own. The experiments of making the records from the material as I have stated and of shaving the cylinder, examination of the fracture, fineness of grain, I made myself.

Signature and certificate waived.

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Bridgeport, Conn., Dec. 6, 1906.

Present—Mr. Holden and Mr. Massie.

Thereupon F. L. THORNBERRY, a witness produced by complainant, having been first duly sworn, testifies as follows:

By Mr. Massie:

*Q.* 1. Please state your name, age, residence and occupation?

*A.* F. L. Thornberry; my residence, 285 Golden Hill St., Bridgeport, Conn.; twenty-seven years of age; my occupation is experimental chemist at the American Graphophone Co.

*Q.* 2. When did you enter the employ of the American Graphophone Co. as experimental chemist? *A.* July 3, 1905.

*Q.* 3. What experience and opportunities did you have in that line before entering the employ of the Graphophone Co.?

*A.* I am a B. S. man from Wesleyan University, having specialized in chemistry. The course was four years.

*Q.* 4. I show you a copy of Macdonald patent No. 606,725, July 5, 1898, and also of Macdonald patent No. 626,709, June 13, 1899. Were you asked to conduct any experiments or tests in connection with these two patents? *A.* I was.

*Q.* 5. Please state briefly what you did.

*A.* I made up several records from each formula, and watched carefully the behavior of the compound during the process of manufacture.

*Q.* 6. What did you do with the compound thus made by each formula?

*A.* The records were molded under my supervision and two dozen records from each formula were put in cartons and handed to Mr. Macdonald, Manager of the factory.

*Q.* 7. Did you make up any other formulæ in connection with these two, and if so, what?

*A.* I used the formulæ of the patents in question as a basis, and added to them the percentage of carnauba as specified by Mr. Aylsworth.

*Q.* 8. What did you do with these last two compositions?

*A.* The records were molded under my supervision, placed in cartons and handed to Mr. Macdonald.

*Q.* 9. Did you make any further tests in regard to these four sets of records, and if so, what? *A.* I did, making a "wear test."

*Q.* 10. What guided you as to the temperature to be used in cooking these four separate batches?

*A.* The temperature for the composition was given in the Macdonald patent of 1899.

*Q.* 11. Comparing the behavior of each of these four different batches, while being compounded, and subsequently while being molded, what differences of behavior, if any, did you observe?

*A.* Absolutely no difference.

*Q.* 12. Did you find that when heated for the purpose of molding, there was any difference in limpidity between any of the four batches? *A.* No.

*Q.* 13. About when did you finish these records?

*A.* I should prefer to see my note book before making answer. (After referring to note book) August 22, 1906.

*Q.* 14. Have you had occasion to examine any of these four sets of records recently? *A.* I have.

*Q.* 15. How do the records of the respective sets compare with regard to the appearance of bubbles or anything else tending to destroy the commercial character of the record surface, or that would indicate the presence of decomposition products?

*A.* There is no difference.

*Q.* 16. How did the records of the four respective sets compare with regard to the fineness of texture or grain, with regard to the presence of "extraneous sounds when the reproducer rubs over it"? *A.* There is no difference.

*Q.* 17. How did the four batches compare in regard to behavior in passing from the liquid to the solid state through an intermediate condition of gradually-reduced plasticity?

*A.* There is no difference.

*Q.* 18. How did they compare in regard to stickiness or tenacity, or adherence to the mold when set? *A.* No difference.

*Q.* 19. How did they compare in their behavior in shrinking away from the mold upon reduction in temperature?

*A.* No difference.

*Q.* 20. How did they compare in regard to shrinking uniformly without warping? *A.* No difference.

*Q.* 22. When was it that you last examined these four sets of records? *A.* About Tuesday, December 4, 1906.

*Q.* 23. How did the records of the four sets compare with regard to any appearance of moldiness, or other indications of injury by moisture, etc., when you last examined them?

*A.* They were equally affected by changes of temperature, the same percentage of each batch of records was affected and the same percentage was not affected.

*Q.* 24. In making those four different sets of molded records, how did they compare with regard to behavior in being reamed while still hot? *A.* No difference.

*Q.* 25. How did the respective records of the four batches compare as the result of "the wear test" carried out by you?

*A.* The records not having carnauba wax did not wear as long as the records containing carnauba wax.

*Q.* 26. By the way, about what percentage of carnauba wax did you employ? *A.* A little over six per cent.

*Q.* 27. In carrying out the wear tests, did you make the test on anything besides the two "Macdonald compositions" and the two compositions containing the little over six per cent. carnauba?

*A.* Yes. I made a wear test on records from the composition used at the present time in the American Graphophone Co.

*Q.* 28. Considering (1) the two batches of "Macdonald composition," (2) the two batches of Macdonald composition with the little over six per cent. carnauba, and (3) the present commercial composition, how did the latter compare with the other two in hardness or durability under the wear test?

*A.* The latter are harder and stood the wear test longer than either of the formed two.

*Q.* 29. Do you know what the composition of the present molded record is or how it compares with the compositions made up by you for the tests?

*A.* I do. The present composition used by the American Graphaphone Co. differs in certain proportions from those in the formula in question.

*Q.* 30. Was any one present when you weighed out the ingredients for the compositions you prepared, and, if so, who?

*A.* Yes. Mr. I. B. Capron and Mr. W. S. Tyler, both of this factory, witnessed it.

*Q.* 31. Was any one present during the cooking of the batches, and, if so, who?

*A.* Yes. Mr. J. Cashman and Mr. E. Lynch, both of this factory, witnessed the cooking of the same.

*Q.* 32. Who actually did the moulding of the different batches of records? *A.* Mr. J. Havey of this factory.

*Q.* 33. Did any one assist you in the "wear tests," and if so, who? *A.* Mr. J. Havey, of this factory.

*Q.* 34. Did anyone assist you in the wear tests in regard to observing the quality of the reproduction from the graphophone; and if so, who?

*A.* Messrs. A. E. Belcher, F. H. Osborne and I. B. Capron.

*Q.* 35. Did you take notes of the weights of the various ingredients taken by you, the temperatures employed, and the results at successive stages of the wear tests, so that you could produce the same if asked to do so?

*A.* I did, and I still have the notes.

*Q.* 36. Will you please produce the various records which you have testified that you made for the purpose of the comparisons?

Recess.

*A.* I produce 96 records, being 24 of each of the four batches. I likewise produce six other records, being one from each of the four batches and two from the ordinary factory stock. These six are the ones used in the wear tests.

One record from each of the four batches is offered in evidence and the same are marked respectively:

Defendant's Exhibit, Thornberry Record, Formula A;

Defendant's Exhibit, Thornberry Record, Formula B;

Defendant's Exhibit, Thornberry Record, Formula A with carnauba;

Defendant's Exhibit, Thornberry Record, Formula B with carnauba;

The six records used in the wear tests are offered in evidence and marked respectively:

Defendant's Exhibit, Thornberry Tested Record, Formula A, No. 3;

Defendant's Exhibit, Thornberry Tested Record, Formula B, No. 6;

Defendant's Exhibit, Thornberry Tested Record, Formula A with carnauba, No. 2;

Defendant's Exhibit, Thornberry Tested Record, Formula B with carnauba, No. 5;

Defendant's Exhibit, Thornberry Tested Record, Regular Columbia No. 1;

Defendant's Exhibit, Thornberry Tested Record, Regular Columbia No. 4.

*Q.* 37. Will you, as far as you can do so conveniently, retain the rest of the special records just produced by you, in order that complainant's counsel may inspect the same if he so desires?

*A.* I will.

*Q.* 38. Will you please produce your note book and refer me to the passages showing the weights of materials employed by you?

*A.* I do so. I will add that I have a typewritten copy of the entries in my note book which relate to this subject.

*Q.* 39. Under date of Aug. 6, 1906, is an entry headed "Formula A. 1898 Pat." and containing signatures. What does this entry relate to, and what do these signatures indicate?.

*A.* This entry relates to the weight of materials called for by Formula A 1898 Patent, and the signatures are those of the gentlemen who witnessed the operation of weighing out these materials.

*Q.* 40. In whose handwriting is this entry, and when was it made?

*A.* It is in my handwriting, and the entry was made on Aug. 6, 1906.

*Q.* 41. When were the materials weighed out?

*A.* The materials were weighed out on Aug. 6, 1906.

*Q.* 42. On a following page is an entry dated Aug. 8, 1906, headed "Formula B. 1898 Pat." and followed by two signatures. What does this entry relate to, and what can you say of the signatures?

*A.* This entry relates to the materials called for in Formula B. 1898 Patent, and the signatures are those of the gentlemen who witnessed the weighing of these materials.

*Q.* 43. In whose handwriting is this entry, and when was it made?

*A.* It is in my handwriting, and was made Aug. 8, 1906, the same day the materials were weighed out.

*Q.* 44. On still a later page, is an entry dated Aug. 14. 1906, headed "Formula A. 1898 Pat. with temp." etc., followed by two signatures. What does this entry relate to, and what are the signatures?

*A.* This entry is the materials called for in Formula A. 1898 patent with temperature, etc., and the signatures are those of the gentlemen who witnessed the weighing of the same.

*Q.* 45. In whose handwriting is the entry, and when was it made?

*A.* It is in my handwriting, and was made on Aug. 14, 1906, the same day that the materials were weighed.

*Q.* 46. On a still later page, is an entry dated Aug. 21, 1906, headed "Formula B, 1898 Pat. with temperature, etc.," and followed by two signatures. What does this entry relate to and what are the signatures?

A. This entry relates to the materials called for in Formula B 1898 patent, with temperature, etc., and the signatures are those of the gentlemen who witnessed the operation of the weighing of these materials.

*Q.* 47. In whose handwriting is this entry, and when was it made?

*A.* The handwriting is mine, and was made on Aug. 21, 1906, the same day as the materials were weighed.

*Q.* 48. At the time you made these entries and the witnesses signed the same, were you satisfied that the figures there given were correct, that is, that you had weighed the materials as stated in these notes? *A.* I was.

*Q.* 49. Have you any notes signed by any parties who witnessed the mixing and cooking of the ingredients weighed out by you; and if so, will you produce the same?

*A.* I have and I now produce the same.

*Q.* 49a. If you made a written report on your test, will you please produce the same?

*A.* Under date of Sept. 4, 1906, I made a written report to Mr. Macdonald, the Manager of the factory, which I now produce.

*Q.* 49b. The four notes produced in answer to *Q.* 49 contain, each at the beginning, certain formula and signatures. What are these?

*A.* These are copies from my note book and the signatures of the gentlemen who witnessed the operation of weighing.

*Q.* 50. Are these copies of the four entries which you have just identified from your note book? *A.* Yes.

*Q.* 51. Please read what appears on these four notes below the signatures of Messrs. Tyler and Capron.

*A.* At the foot of each of the four notes appears the following:

"This is to certify that the above ingredients were mixed together and cooked until they became a homogeneous mixture, and that a constant temperature of 450 F. was maintained throughout the cooking.

(Signed) J. CASHMAN,
E. LYNCH."

*Q.* 52. What is the note book which you have produced?

*A.* It is a note book kept by me containing notes of all experiments that I perform for Mr. Macdonald.

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*Q*. 53. Is it your private property?

*A*. While I am in the employ of the American Graphophone Co., yes; subject to Mr. Macdonald's demand.

*Q*. 54. Why do you keep these notes, for your own amusement?

*A*. I keep them for the benefit of the American Graphophone Co.

*Q*. 54a. Do you keep them as a part of your regular duties?

*A*. Yes.

*Q*. 55. Your examination was interrupted to examine the witnesses Cashman, Lynch, Tyler, Capron and (by stipulation) Belcher and Osborne. These witnesses have identified certain other papers. Do you know anything about these papers?

*A*. I do. They are verifications of the various operations performed by me and the various witnesses whose names are attached to these papers.

*Q*. 56. Were these names attached in your presence and at your request? *A*. Yes.

Dec. 7, 1906.

Second Thornberry Deposition.

Present—Mr. HOLDEN and Mr. MASSIE.

And thereupon the witness F. L. THORNBERRY is recalled.

By Mr. MASSIE:

*Q*. 57. Are you the same F. L. Thornberry who has already been examined in this case? *A*. I am.

*Q*. 58. Have you at my request made an examination in the literature to ascertain whether or not the following bodies contain any alcohol, namely, Bees wax, Chinese wax, and Palm wax; and if so, with what results?

*A*. I have, and I find that there is no free alcohol in Palm wax or Bees wax. There is just the slightest trace of free alcohol in Chinese wax.

*Q*. 59. Will you please reduce the figures in the Aylesworth patent to the same terms as the figures given in the Macdonald patent No. 606,725, July 5, 1898, as Formula B?

| *A*. | *Macdonald Formula B* | *Aylsworth* |
|---|---|---|
| Stearic Acid | 300 lbs. | 300 lbs. |
| Aluminum powder | 1.5 " | 1.16 " |
| Caustic soda lye, B 37½° | 9.0 " | 9.23 " |
| Sal soda | 60.0 " | 60.0 " |
| Ceresin | 60.0 " | 64.18 " |
| Water | 12 gals. | 30 gals. |
| Carnauba | none | 64.18 |

Deposition closed subject to objections and cross-examination.

BRIDGEPORT, Conn., Dec. 14, 1906.

Met pursuant to agreement.

Present—Frank L. DYER, Esq., for complainant; C. A. L. MASSIE, Esq., for defendant.

CROSS EXAMINATION of the Witness THORNBERRY, which was suspended to take the testimony of the remaining Bridgeport witnesses.

By Mr. DYER:

*xQ.* 60. Having reference to the report of Sept. 4, 1906, which you made to Mr. Macdonald, upon what did you base the statement that Messrs. Belcher, Capron and Osborne had been connected with the Graphophone Co. for more than seven years?

*A.* I asked the gentlemen themselves.

*xQ.* 61. And in connection with the compositions made by you and which you tested, did you satisfy yourself as to the identity of the several ingredients or were you simply told that certain ingredients were used?

*A.* I had a personal knowledge of the ingredients that were used.

*xQ.* 62. Before your connection with the Graphophone Co. had you had any experience with wax compositions for sound record tablets or blanks? *A.* No, sir.

*xQ.* 63. What experience had you had in organic chemistry in general?

*A.* I had two years' theory and one year's actual laboratory work in college.

*xQ.* 64. Was this in connection with organic chemistry alone?

*A.* The theory and practice referred to in the previous question pertained to organic chemistry.

*xQ.* 65. That is to organic chemistry exclusively? *A.* Yes, sir.

*xQ.* 66. In the manufacture of the compositions with which you experimented, kindly describe the process followed in making the wax and particularly as to the time or period when the Carnauba was added.

*A.* The materials were weighed, placed in the kettle and allowed to cook about 16 hours. By materials I mean the stearic acid was melted, the solution put in for the purpose of saponification, using during this process of saponification a temperature of about 450 degrees F. This much of the wax was allowed to cook about 2½ hours at this temperature mentioned before the Carnauba wax was added.

*xQ.* 67. Was the Ceresin added prior to the saponification of the stearic acid or was it added with the Carnauba?

*A*. There was no Ceresin added.

*xQ*. 68. What form of hydro carbon was used, paraffine?

*A*. Paraffine.

*xQ*. 69. When was the paraffine added?

*A*. At the same time as the Carnauba wax.

*xQ*. 70. How long was the composition cooked after the Carnauba was added? *A*. About 13½ hours.

*xQ*. 71. What was the purpose of cooking the material for so long a time after the addition of the Carnauba?

*A*. The experiment was started in the middle of the afternoon, and as nothing could be done in the amount of time left during the working day, it was allowed to cook during the night until the next morning.

*xQ*. 72. Am I to understand from this that the long period of cooking was unimportant or unnecessary?

*A*. I would say neither, merely a matter of convenience.

*xQ*. 73. Please explain your last answer?

*A*. The 16 hours of cooking did no harm and saved the trouble of bringing the wax into a fluid condition when needed the next day.

*xQ*. 74. Do I understand that during this entire period the temperature was maintained at about 450 F.?

*A*. You do. That is correct.

*xQ*. 75. How long do you consider it necessary to cook the composition after the Carnauba has been added?

*A*. Anywhere from 3 to 5 hours.

*xQ*. 76. Is the manufacture of the wax composition under your charge or direction in this factory; that is to say are you the wax chemist? *A*. I am the wax chemist.

*xQ*. 77. During the experiments you made, did you observe the composition during its manufacture after the Carnauba was added? *A*. I did.

*xQ*. 78. In making this composition after the addition of the Carnauba, did you observe any phenomenon from which you would conclude that a chemical reaction was taking place?

*A*. Yes, sir.

*xQ*. 79. What chemical reaction did you conclude was taking place in the composition after the Carnauba was added?

> It is stipulated by Counsel for defendant that when Carnauba wax is added to the heated composition containing free Stearic acid, the free Myricyl alcohol of the Carnauba wax combines with the free Stearic acid to form a wax-like compound ether, substantially as described in the Aylsworth patent in suit.

*xQ.* 80. In answer to *Q.* 9, you refer to a "wear test." Did you make any other physical test of the records made with the compositions referred to in your deposition and if so, what were they?

*A.* I made no other physical tests.

*xQ.* 81. As I understand it, your tests were made with the composition employing about 6% Carnauba?

*A.* That is correct.

*xQ.* 82. In answer to question 12, you referred to the limpidity of the several compositions. What test did you make to ascertain the relative limpidity of these compositions?

*A.* I made an eye test.

*xQ.* 83. That is to say, you simply looked at the several compositions and concluded that the limpidity of one was the same as each of the others?

*A.* After careful observation, I came to that conclusion.

*xQ.* 84. In answer to *Q.* 17, you referred to the behavior of the several compositions in passing from the liquid to the solid state. What tests, if any, did you make regarding this phenomena?

*A.* A careful observation.

*xQ.* 85. That is to say, you made what you have referred to as an eye test? *A.* Yes, sir.

*xQ.* 86. In answer to *Q.* 18, you referred to the property of the several compositions in reference to their stickiness, or tenacity, or adherence to the mould when set, or rather as I understand it, to the absence of these properties in the composition. What test, if any, did you make regarding this phenomena?

*A.* A careful observation.

*xQ.* 87. Here, again, as I understand it, you made simply an eye test? *A.* Yes, sir.

*xQ.* 88. In answer to *Q.* 19, you referred to the behavior of the compositions in shrinking away from the mould upon reduction in temperature. What test, if any, did you make regarding this phenomena?

*A.* A careful observation, by an eye test, as before.

*xQ.* 89. In answer to *Q.* 20, you referred to the absence of warping in the several compositions, during the shrinkage. What tests, if any, did you make regarding this phenomena?

*A.* A careful observation by the eye test as before.

*xQ.* 90. Kindly read your answer to *Q.* 23 and explain the same more in detail.

*A.* In other words, some records of the several compositions had the so-called moisture bloom and some of them did not. By the same percentage, I mean that about the same number of each composition was affected.

*xQ.* 91. That is to say, as I understand it, you made twenty-four records each of four separate compositions, and you found that the same percentage of each set of twenty-four was affected by the so-calld moisture bloom?

*A.* I saved twenty-four records from each composition, and upon looking at them later, found that about the same number of each composition was affected by the so-called moisture bloom.

*xQ.* 92. What was this percentage? That is to say, how many records of each set were imperfect?

*A.* I do not remember exactly the number.

*xQ.* 93. Did it not impress you as an interesting, if not remarkable coincidence that the same percentage of imperfect records should have developd in four separate compositions?

Objected to as incompetent, and not a subject for testimony.

*A.* In the first place, I do not like the use of the word "same" by the counsel for the complainant. It is not peculiar for any number of records of practically the same composition to have the so-called moisture bloom.

Counsel for complainant will explain that the word "same" was used by him for the reason that in answer to *Q.* 23 that word was used by the witness.

*xQ.* 94. In the manufacture of defendant's records, are the records reamed while hot or warm and before the composition is hard?

Question objected to as outside the scope of the direct examination, as possibly tending to disclose unnecessarily defendant's factory processes, further objected to on the ground that it does not appear that the witness is familiar with the regular factory operations as distinguished from the laboratory work. The witness may testify as to whether or not the particular records made by him were reamed while hot; but, as to disclosing the factory processes in general, he may decline to answer until required to do so by the Court.

*A.* I prefer not to answer.

*xQ.* 95. In the case of the particular records which you made, were they reamed while hot?

*A.* Well, they were reamed in a semi-plastic state.

*xQ.* 96. Assume a composition composed of bees wax and carnauba wax and another composition composed of ozokerite and carnauba wax. If either of these compositions is heated so as to form an intimate mixture, would there be any chemical reaction?

> Question objected to as not within the scope of the direct examination. As to this and any similar questions, the complainant makes the witness his own.

*A.* In my opinion a composition consisting of Carnauba and ozokerite would not undergo any chemical reaction unless the temperature was raised sufficiently high to liberate some of the ethereal salts in the form of vapor, or the free myricyl of alcohol. As regards Carnauba and bees wax, there would be a neutral interchange at the sufficiently high temperature that is required between the various molicules of the two waxes.

*xQ.* 97. What temperature would be required to affect the chemical reaction in the case of ozokerite and Carnauba?

> The same objection and notice which is understood as implied without being repeated.

*A.* I do not think you understand my previous answer. In the case of Carnauba and ozokerite, if the temperature is raised to the boiling point of the various ingredients in Carnauba wax, these ingredients will pass off in the form of vapor and do not unite with ozokerite.

*xQ.* 98. Then, as I understand it, with a mixture of ozokerite and Carnauba wax there could be no chemical reaction between the carnauba or any of its constituents and the ozokerite or any of its constituents? *A.* In my opinion that is correct.

*xQ.* 99. Regarding the composition of bees wax and carnauba wax, what is meant by neutral interchange between the molecules?

*A.* That is another way of saying that you start with an intimate mixture of carnauba wax and bees wax and after cooking for any length of time, providing the temperature is not high enough to vaporize the several constituents of the two waxes in question, you will have remaining an intimate mixture of carnauba wax and bees wax.

*xQ.* 100. Then, as I understand it, in the case of a mixture of bees wax and carnauba, there is no chemical reaction between the carnauba or any of its constituents, and the bees wax or any of its constituents?

*A.* In my opinion, the reaction that would take place according to the stipulations in the previous answer, would be what is called in chemistry "a neutral reaction."

*xQ.* 101. Is it not a fact that bees wax and carnauba wax are both salts of, or esters of, myricyl alcohol?

*A.* In my opinion, they contain salts of myricyl alcohol but not esters.

*xQ.* 102. That being so, how could there be reaction between salts of the same alcohol?

> The objection and notice after *xQ.* 96 are repeated.

*A.* I should say that the counsel for the complainant does not fully grasp the meaning of the word "neutral" as defined in the chemical world.

Recess until 1:30 P. M.

*xQ.* 103. What is your meaning of "neutral reaction"?

*A.* By neutral reaction, I mean that whatever reaction takes place goes to the positive extreme as far as it does to the negative extreme.

*xQ.* 104. What temperature would be necessary to effect a neutral reaction between carnauba and bees wax?

*A.* As regards the combination of carnauba and bees wax, I wish to have it placed on record that I have never experimented with this combination. The answers to the previous questions have been given from a theoretical standpoint solely. The field of organic chemistry is so large, and our cherished and rock founded truths are being and have been shaken so often, that any answer to a question to-day would not apply at all to the same question if asked to-morrow.

*xQ.* 105. Speaking of to-day, and from the best of your knowledge in a theoretical sense, do you consider that if carnauba were mixed with bees wax there would be any such reactions, neutral or otherwise, that would be similar to those that result when carnauba is added, in the wax compositions with which we are dealing here?

> Former objections and notice repeated. Question further objected to as hypothetical and indefinite. The word "similar" is pointed out as being in this connection indefinite.

*A.* Even the best of our theories prove us false when engaged in actual practice, consequently, I answer "I do not know."

*xQ.* 106. Would you consider that, in the mixture of carnauba and bees wax, under the presence of heat, a wax-like compound ether would be formed as is the case when carnauba is added as an ingredient in the compositions with which we are dealing?

*A.* Not having experimented with this combination, I do not know.

*xQ.* 107. Are you able to say, as a matter of theory, based on your experience in organic work, whether in the case of a mix-

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ture of carnauba and bees wax any reactions would take place between the alcohols of the carnauba as such and the acids of the bees wax as such, or vice versa?

*A.* Not having had any experience with the combination of carnauba and bees wax, any theory that I might have on the subject would be so hypothetical as to be useless.

*xQ.* 108. You have stated that the composition which was tested by you contained about six per cent. of carnauba. To what extent did that composition differ from the regular composition used by the defendant company?

*A.* An answer to this question would lead up to confidential facts of the defendant company, consequently I prefer not to answer.

*xQ.* 109. Mr. Macdonald, in this case, criticized the conclusion reached by Mr. Aylsworth that, from his analyses, he was of the opinion that defendant's composition contained slightly less than eight per cent. of carnauba, and Mr. Macdonald stated that, as a matter of fact, the composition contained about twice that amount of carnauba. Now, I ask of you as the wax chemist, what the amount of carnauba is that is used in defendant's composition? *A.* Mr. Macdonald's statement is correct.

*xQ.* 110. Mr. Macdonald only gave an approximate answer. I would like to know the exact amount, that is to say, the exact amount of carnauba for each 100 pounds of stearic in the composition?

*A.* The answer to this question would disclose confidential data, consequently, I prefer not to answer.

*xQ.* 111. And you refuse to answer even when your counsel is entirely willing that you should?

> Defendant's counsel states that if the information be necessary to complainant, the witness Thomas H. Macdonald, who is the factory manager, will be able to answer the question on the cross-examination, and can judge even better than defendant's counsel now present, whether or not the question should be answered.
>
> Mr. Dyer—In view of the assurance of counsel for defendant that the information called for will be furnished by the witness, Macdonald, who has not as yet been cross-examined, further cross-examination of this witness on the point is waived.

*xQ.* 112. Will you kindly furnish me the following: (1) Four of the records made by you which you have referred to as No. 2, made of a composition of Formula A of the Macdonald patent, with 6 per cent. of carnauba, and I will ask you to mark each of these "No. 2 F. L. T." in order that they may be identified; (2) Four of the records made by you which you have referred to as No. 3 made of a composition of Formula A of the Macdonald patent, and I will ask you to mark each of them "No. 3, F. L. T." in order that they may be identified; (3) Four of the records made by you which you have referred to as No. 5 made of a composition of Formula B of the Macdonald patent with six per cent. of carnauba, and I will ask you to mark each of these "No. 5 F. L. T." in order that they may be identified; (4) Four of the records made by you which you have referred to as No. 6 made of a composition of Formula B of the Macdonald patent, and I will ask you to mark each of these "No. 6 F. L. T." in order that they may be identified.

*A.* I will very gladly give you these records.

Counsel for complainant requests counsel for defendant to furnish him with a copy of the notes referred to in *Q.* 38.

In reply to the request, defendant's counsel hands to complainant's counsel a carbon copy of the typewritten copy referred to.

*xQ.* 113. I notice when you were called as a witness that you did not give a direct answer to *Q.* 58. You were asked concerning alcohol generally, and you answered with reference in particular to free alcohol. Do I understand that bees wax and palm wax contain no alcohols and that Chinese wax contains only a trace of alcohol.

*A.* An answer to this question would be similar to an answer required when asked if white was contained in the color pink. We know that red and white, when combined, give pink, but the white has lost its individuality when in combination with the red. The radical for myricyl alcohol is present in both bees wax and palm wax; not in molecular arrangement with the hydroxyl attached, but combined with the acid radical to form an ether of myricyl palmitate. In the case of Chinese wax, however, to the best of my knowledge, there is present myricyl alcohol as such. By that, I mean in the free state.

*xQ.* 114. Do you understand that to result in the formation of compound ethers, the alcohol must exist in the free state; that is to say, if these waxes are used as an ingredient in the compositions with which we are here dealing?

*A.* To the best of my knowledge, they can.

RE-DIRECT EXAMINATION, by Mr. MASSIE:

*R-dQ*. 115. Besides the "wear test" which you made, these special records have been subjected to the test of changes of temperature since last August, have they not? *A*. They have.

*R-dQ*. 116. As to the behavior of these four batches, you were stating what you observed with your own eyes, were you not?

*A*. That is correct.

*R-dQ*. 117. The 96 special records produced by you have been kept together, in the same crate in which they now appear in this room, ever since they were finished and put in cartons, were they not?

*A*. For the first few days after the records were handed to Mr. Macdonald, they were allowed to stand on the table in this room. They were then placed in the crate and placed in Mr. Macdonald's private storeroom, which is the room just back of this one.

Signature and certificate waived.

Dec. 6, 1906.

Present—Mr. HOLDEN and Mr. MASSIE.

Thereupon J. CASHMAN, a witness produced by defendant, being first duly sworn, deposes as follows:

By Mr. MASSIE:

*Q*. 1. What is your name, age, residence, and occupation?

*A*. John Cashman; age 40; Bridgeport, Conn.; mixer.

*Q*. 2. Where are you employed?

*A*. The American Graphophone Co.

*Q*. 3. What do you mix, and what is it for.

*A*. Records.

*Q*. 4. Do you mix composition for the cylinder records at the factory of the American Graphophone Co?

*A*. Yes, sir.

*Q*. R. How long have you been employed as mixer by the American Graphone Co?

*A*. About eight years and a half.

*Q*. 5. I show you four papers and ask if the signature "J. Cashman" there appearing is your signature?

*A*. It is. I signed those papers.

*Q*. 6. Do you recall the circumstances?

*A*. I remember about it all right.

*Q*. 7. Did you see Mr. Thornberry and the other gentlemen when their materials were weighed out?

*A*. Yes, sir, I was looking at them.

*Q*. 8. What did they do with the materials as soon as they finished weighing them?

*A*. Put them in a kettle and cooked them up.

*Q*. 9. Who put them in the kettle?

*A*. I think it was Mr. Thornberry.

*Q*. 10. What did you have to do about it?

*A*. I didn't do anything. Mr. Lynch cooked them up, but I saw it. I was right there.

*Q*. 11. Did you observe the temperature at which they were cooking? *A*. No, sir. He had charge of the temperature.

*Q*. 12. After these batches were cooked, what was done with the mixtures.

*A*. They were taken down stairs and molded.

*Q*. 13. Did you see any of them in the molding room?

*A*. Yes, sir.

Deposition closed subject to objections and cross examined.

No cross-examination.

Thereupon EDWARD LYNCH, a witness produced by defendant, having been first duly sworn, deposes as follows:

By Mr. MASSIE:

*Q*. 1. Please give your name, age, residence, and occupation.

*A*. Edward Lynch; age 35; Bridgeport, Conn.; mixer and moulder.

*Q*. 2. Where are you employed?

*A*. In the molding department of the American Graphophone Co.

*Q*. 3. About how long have you been there?

*A*. About eight years.

*Q*. 4. I show you four papers bearing a signature "E. Lynch," are these signatures your own? *A*. Yes.

*Q*. 5. Do you recall the matters that these papers relate to?

*A*. Yes.

*Q*. 6. Did you see Mr. Thornberry and Messrs. Tyler and Capron when they were weighing out the materials? *A*. Yes.

*Q*. 7. What did they do with the materials after they were weighed out?

*A*. After they were weighed out, Mr. Thornberry asked me to cook these. I didn't see anything but stearic acid. The stearic acid came to me and I cooked it up to this temperature of 450, and I put the solution in the melted stearic acid.

*Q*. 8. You had charge of the kettle at the time? *A*. Yes.

*Q.* 9. You observed the thermometer yourself?

*A.* Yes. I did not stay there the whole time, there was a night man there and he was supposed to keep it at 450 degrees the same as I was. The cooking of the stearic acid and the solution went on night and day.

*Q.* 10. I understand that, after Mr. Thornberry had finished weighing out the materials he gave the stearic acid to you and you put it in the kettle and melted it; and, after it was melted, then Mr. Thornberry himself put in the solution; after which the whole batch was kept by you at the temperature named?

*A.* Yes.

*Q.* 11. There are four papers there, each bearing your signature. Did you do this same thing with the four different batches?

*A.* I don't know. I couldn't say whether I had four or not.

*Q.* 12. Assuming that here are papers relating to four different batches that on last August you signed, all four of them, what is your best belief as to whether or not there were four batches?

*A.* I think there were.

*Q.* 13. After these batches were cooked, do you know what was done with the composition?

*A.* Yes. They were taken from my room and taken down stairs.

*Q.* 14. Do you remember now, who took them down stairs?

*A.* Yes. I helped to take them.

*Q.* 15. Where did you take them; what room?

*A.* Mr. Bannon's room, the master moulding department.

*Q.* 16. Do you know what was done with the compositions?

*A.* I don't know anything about it.

Deposition closed subject to objections and cross examination.

No Cross-Examination.

Thereupon W. S. TYLER, a witness produced by defendant, being first duly sworn, deposes as follows:

By Mr. MASSIE:

*Q.* 1. Please state your name, age, residence, and occupation.

*A.* Walter S. Tyler; age 29; 96 Sherwood Ave., Bridgeport, Conn.; I have charge of the cylinder and disk experimental department at the Factory of the American Graphophone Co.

*Q.* 2. How long have you been at the Factory?

*A.* Since July, 1905.

*Q.* 3. What training and experience have you had to equip you for the position you occupy?

*A.* I graduated from the University of Illinois in 1900, from the Electrical Engineering course, and was employed by the Chicago Telephone Co. for a year and a half in experimental work, and after that I was with the Lambert Co., Chicago, for three years, the most of this time being as manager of their factory.

*Q.* 4. What did the Lambert Co. make at this factory?

*A.* Celluloid phonographic records.

*Q.* 5. I produce a note book issued to Mr. F. L. Thornberry, and call your attention to entries under date of Aug. 6, 8, 14, and 21, 1906, each of which bears the signature, "W. S. Tyler." Whose signature is this if you know?

A. The signature is mine.

*Q.* 6. Do you recall the circumstances to which these four entries relate? *A.* Yes, sir, I do.

*Q.* 7. Please state briefly, in your own language, what happened.

*A.* The first entry, Aug. 6, Formula A. On that date I went with Mr. Thornberry to the weighing and mixing room where these weights were performed in my presence, and which I know to be correct. The entry of Formula B, on Aug. 6, part of these weights were performed in the chemical laboratory, and part in the weighing and mixing room, and were witnessed by me. The weights given on Aug. 14 were performed in the weighing and mixing room, and are correct as given and on Aug. 21, the weights as given in the note book are correct.

*Q.* 8. Have you any private memorandum of your own relating to these weights? *A.* Yes, sir

*Q.* 9. Can you produce the same if desired by complainant's counsel, of course not disclosing any other private entries in your book? *A.* Yes, sir.

*Q.* 10. Did you subsequently sign any memoranda relating to the materials weighed out by Mr. Thornberry? *A.* I did.

*Q.* 11. I hand you four papers at the foot of each of which appear the signatures "J. Cashman and E. Lynch." Whose is the first signature on each of these papers? *A.* My own.

Deposition closed subject to objections and cross examination.

No Cross-Examination.

Thereupon ISAAC B. CAPRON, a witness produced by defendant, being first duly sworn, deposes as follows:

By Mr. Massie.

*Q.* 1. State your name, age, residence and occupation.

*A.* Isaac B. Capron; age 35; 227 Lewis St., Bridgeport, Conn.; clerk in the metal master department at the American Graphophone Co.

*Q.* 2. How long have you been in that department?

*A.* About five years.

*Q.* 3. I call your attention to four entries in Mr. Thornberry's note book under dates Aug. 6, 8, 14, and 21, 1906, each of which bears the signature "I. B. Capron." Whose signatures are these if you know? *A.* Mine.

*Q.* 7. Do you recall the circumstances to which these four entries relate? *A.* Yes.

*Q.* 8. How did you come to sign these entries?

*A.* I was asked to witness Mr. Thornberry weighing the different ingredients in these formulas.

*Q.* 9. Please state briefly, in your own language, what took place on this occasion?

*A.* Mr. Tyler and I were helping Mr. Thornberry in the mixing room. We watched him as he weighed the different ingredients he put into each formula, and we saw that he got the right amount.

*Q.* 10. What is your best belief as to the correctness of these four entries I call to your attention. *A.* I believe they are correct.

*Q.* 11. I call your attention to four papers already identified by Messrs. Cashman, Lynch, and Tyler, these papers bear the signature "I. B. Capron." Whose signature is that? *A.* Mine.

*Q.* 12. Do you remember about that time, or a little after, making some wear tests for Mr. Thornberry, or at least taking some part in such tests? *A.* I do.

*Q.* 13. Please state briefly in your own language what was done?

*A.* Mr. Thornberry brought in six records on a small pegboard, and he, Mr. Thornberry, put the record on the machine himself, and I tested the record and listened to it. Then he put another one on and so on with the whole six. I picked out the one that was best or next best.

*Q.* 14. I show you ten papers, each bearing the signature "I. B. Capron." Who wrote this signature, if you know? *A.* I did.

*Q.* 15. What is your belief as to the correctness of the ten certificates signed by you?

*A.* They are correct, as far as I know.

The first of these certificates reads as follows (omitting the printed heading):

> August 29, 1906.
>
> This is to certify that I have listened to a reproduction of the following records, viz.: record No. 1, record No. 2 and record No. 3. This reproduction was

at the end of the fiftieth reproduction. Also that I consider that record No. 1 has the best surface, record No. 2 has the next best surface and that record No. 3 has the worst surface.

(Signed) I. B. CAPRON.

It is stipulated that, of the ten Capron certificates just identified, the alternate ones relate to records No. 1, No. 2 and No. 3 while the other certificates relate to records No. 4, No. 5 and No. 6; that the first two purport to be at the end of the fiftieth reproduction, the next two at the end of one hundred, the next two at the end of the one hundred and fiftieth, the next two at the end of the one hundred and seventy-fifth and recite that the records No. 3 and No. 6 are entirely worn out, and the last two at the end of the two hundredth reproduction, and recite that records No. 2 and No. 5 are entirely worn out. With these changes made, the ten certificates are identical in language.

*Q.* 16. What experience, if any, have you had in testing and listening to reproduction of sound records.

*A.* Part of my duty has always been to test the first record made from the master matrix.

*Q.* 17. The records made from the master matrices are the ones that are put on the market?

*A.* No, sir. The first test from the master matrix is to look for defects in the master matrix.

*Q.* 18. And if the first record made from the master matrix passes your test, then do the others go out?

*A.* We send that sample to New York for their approval.

Deposition closed subject to objections and cross-examination.

No cross-examination.

For the purpose of this suit, it is stipulated that if A. D. BELCHER and F. H. OSBORNE were duly examined as witnesses for defendant, they would testify that Mr. Belcher has been at the Graphophone Co. factory a number of years, as one of the chief testers, in listing to test reproductions of sound records; and that Mr. Osborne has also been at the factory for a number of years as an assistant to Mr. Macdonald in the laboratory. That each of these gentlemen gave ten certificates identical respectively with the ten identified with the witness Capron; that each of them identifies his own signatures to the certificates, and stated that he recalled the circumstances and that his certificates were correct.

It is further stipulated that these parties will be produced for cross-examination if complainant's counsel so desire.

Thereupon JOHN HAVEY, a witness produced by the defendant, being first duly sworn, deposes as follows:

By Mr. MASSIE:

*Q.* 1. Please state your name, age, residence and occupation.

*A.* John Havey; age 16; 324 Hancock Ave., Bridgeport, Conn.; cylinder and disk experimental department, at the factory of the American Graphophone Co.

*Q.* 2. Do you know Mr. F. L. Thornberry, who is now present in the room? *A.* Yes, sir.

*Q.* 3. Do you remember making some special records for him several months ago? *A.* Yes, sir.

*Q.* 4. Please tell us briefly, what you remember about it.

*A.* I remember I molded them for him at 410 degrees.

*Q.* 5. Were they cylinder records or disk records?

*A.* Cylinder.

*Q.* 6. Do you remember about how many of these special records you made for him?

*A.* I don't remember how many.

*Q.* 7. Do you remember who brought the compositions down to be molded by you? *A.* Mr. Cashman and Eddie Lynch.

*Q.* 8. Is that John Cashman? *A.* Yes.

*Q.* 9. What did you do with the records after you molded them? *A.* We saved some and put some back into the pot.

*Q.* 10. Who took those that were saved?

*A.* Mr. Thornberry.

Deposition closed subject to objections and cross-examination.

No cross-examination.

Adjourned to the same place to-morrow morning, December 7th, at ten o'clock.

December 7th, 1906.

Met pursuant to adjournment.

Present as before.

And thereupon L. FARINI, having been duly sworn, deposes as follows:

By Mr. MASSIE:

*Q.* 1. Please state your name, age, residence and occupation?

*A.* L. Farini; age 52; Bridgeport, Conn.; Supt. of metal master department of the Factory of the American Graphophone Co.

*Q*. 2. Does that include the mixing and moulding departments?

*A*. It does.

*Q*. 3. How long have you been familiar with the compositions for cylinder sound-records and blanks? *A*. About eight years.

*Q*. 4. Have you any knowledge of the use of Carnauba wax by the American Graphophone Co. in making compositions for sound-records; and if so, for what purpose is the Carnauba used?

*A*. It is used for the purpose of hardening the wax, and increasing its durability.

*Q*. 5. How long have you been familiar with the facts that Carnauba wax is employed, and may be employed, for the purpose of hardening these wax compositions so as to increase the durability of the sound records?

*A*. Since about the beginning of 1897.

*Q*. 6. In what manner do you fix that date?

*A*. I was familiar with the use of Carnauba almost ever since I have been at the Graphophone factory, and its use was for hardening purposes.

*Q*. 7. Do your duties comprise the supervision of the mixing of the ingredients, the cooking, and the actual moulding of the cylinder records?

*A*. I should say yes, but in regard to the moulding there is a foreman who looks after the moulding operations under my supervision.

*Q*. 8. What can you say as to the presence of Carnauba wax in the composition now employed for defendant's Columbia records?

*A*. There is a considerable amount of Carnauba wax present in the composition.

*Q*. 9. Can you say about when Carnauba wax was employed in your molded records in substantial quantity, as a regular product?

*A*. I can positive say when I started to keep a record of the Carnauba used in large quantities, though my impression is that this record of mine was not started precisely at the time when its use was adopted. At the time I mention, the department was not under my immediate supervision.

*Q*. 10. I understand that, according to your present recollection, the Graphophone Co. had been using Carnauba wax for hardening its cylinder composition for some time before you began to keep records of the fact in your department? *A*. Yes.

*Q*. 11. What is the date of your first record of the use of Carnauba wax in the composition for moulded cylinders?

*A*. (Witness refers to memorandum.) I have some notes which I took from our books.

*Q.* 12. Will you please produce the book from which you take the notes. *A.* I do so.

*Q.* 13. What is this book which you have produced?

*A.* A record of raw material received and mixed.

*Q.* 14. Is this book kept by you as a part of your regular duty?

*A.* It is. I was not instructed to keep this book. It is a memorandum of the weekly reports I hand in to the main office.

*Q.* 15. Please refer to the book and read the first date showing. the receipt of Carnauba, and the amount of Carnauba?

*A.* April 24, 1903; 4020 lbs. of Carnauba, also 500 of the same transferred to me from Mr. G. L. Funnell.

*Q.* 16. Please read from your book the successive dates in which Carnauba is mentioned, and the amount of Carnauba on each date?

*A.* May 4, 1903, 3008 lbs. of Carnauba; on June 17, 1903, 3213 lbs. of Carnauba; on Aug. 27, 1903, 2153 lbs. of Carnauba; Sept. 1, 1903, 2438¼ lbs. of Carnauba; on Sept. 5, 1903, 2093 lbs. of Carnauba; on Sept. 25, 1903, 2484 lbs. of Carnauba; on Sept. 30, 1903, 2001½ lbs. of Carnauba; Oct. 2, 1903, 2031 lbs. of Carnauba; on Oct. 3, 1903, 1812 lbs. of Carnauba; on Oct. 7, 1903, 2028 lbs. of Carnauba; on Oct. 9, 1903, 1582 lbs. of Carnauba; on Oct. 15, 1903, 2649 lbs. of Carnauba; on Oct. 21, 1903, 6105¾ lbs. of Carnauba; on Oct. 29, 1903, 8203 lbs. of Carnauba; on Nov. 18, 1903, 6152½ lbs. of Carnauba; on Nov. 30, 1903, 4143¼ lbs. of Carnauba; Dec. 15, 1903, 4000 lbs. of Carnauba. That concludes that year.

*Q.* 17. Without reading out from your book for the ensuing time, can you state whether or not the use of Carnauba continued as shown by your book? *A.* It has.

*Q.* 18. The entries from which you have read in answer to *Q.* 16 indicate that those quantities of Carnauba wax were received by your department? *A.* Yes.

*Q.* 19. Where did you get that wax?

*A.* It is supplied to me by the factory.

*Q.* 20. What became of it all?

*A.* It went into the mixtures, and afterwards into records.

*Q.* 21. The book you have produced is ruled into parallel columns, and on the right hand side, under the column headed "Received" are the entries from which you have read?

*A.* Yes.

*Q.* 22. On the extreme left of each page are the dates. While at the head of each column, extending across the rest of the top of each page I find the following: "Stearic—Caustic—Ceresin—Al. Hyd.—Res. Oil—Sal. S." What do these headings refer to?

*A.* The ingredients used at that particular date. It would show the absence of Carnauba, however, on any date prior to page 117 of my book, since the first entry relating to Carnauba is almost at the bottom of that page. Beginning on the next page, there is a column headed "Carnauba."

*Q.* 23. Thus, for example, during the week ending April 30, you had mixed up in your department 5278 lbs. of stearic acid, 460 lbs. of Caustic soda, 1319 lbs. of Ceresin, 46 lbs. of Aluminum Hydrate, 375 lbs. of Sal. Soda, and 988 lbs. of Carnauba wax? *A.* That is correct.

*Q.* 24. Independent of this box, have you any recollection as to whether or not Carnauba wax was used in quantities about as indicated by this book?

*A.* My impression is, that as it was used, or being used in large quantities, it prompted me to make the suggestion that I make an entry of it in my book.

*Q.* 25. Have you any doubt whatever that Carnauba wax was used as a regular ingredient of the moulded wax composition at this factory during 1903 and down to the present time?

*A.* No doubt whatever.

*Q.* 26. Are you willing for complainant's counsel to inspect this book which you produce? *A.* Yes.

Deposition closed subject to objections and cross examination.

BRIDGEPORT, Conn., Dec. 14, 1906.

Met pursuant to agreement.

Present—FRANK L. DYER, Esq., for Complainant; C. A. L. MASSIE, Esq., for Defendant.

CROSS EXAMINATION of the witness, L. FARINI, it having been postponed to take the testimony of the ensuing Bridgeport witnesses.

By Mr. DYER:

*xQ.* 27. Do you recall when you entered the employ of the American Graphophone Ca.?

*A.* About ten years ago.

*xQ.* 28. That is to say, about 1896?

*A.* Between '96 and '97.

*xQ.* 29. Have you ever had any connection with the manufacture of wax compositions for defendant? *A.* I have.

Raymond R. Wile Research Library

*xQ*. 30. What connection did you have with this particular branch of the defendant's business?

*A*. When I first came with the company, I came as a photographer, and afterwards took charge of the mixing and moulding department.

*xQ*. 31. How long have you had charge of this department?

*A*. I should say about eight years.

*xQ*. 32. Who did you succeed?

*A*. A man by the name of Storms, I believe.

*xQ*. 33. Do you recall Mr. Storms' full name?

*A*. I don't know his full name.

*xQ*. 34. In answer to *Q*. 5 you state that since 1897 you have been familiar with the fact that carnauba is employed for hardening wax compositions. Is that the only property of carnauba that you have ever been familiar with as an ingredient?

*A*. It is.

*xQ*. 35. In answer to *Q*. 22, you give certain abbreviations of ingredients most of which I think I understand. For instance, the word "stearic" means stearic acid; the word "caustic" means caustic soda; the abbreviation "Al. Hyd." means aluminum hydrate; and the abbreviation "Sal. S." means sal. soda. Is this correct?

*A*. That is correct so far.

*xQ*. 36. What is the meaning of the abbreviation "Res. oil?"

*A*. Residual oil.

*xQ*. 37. Is residual oil used as an ingredient in defendant's composition, and if so, for what purpose? *A*. It is not used.

*xQ*. 38. Do you mean that it is not used now or it never has been used? *A*. It is not used now.

*xQ*. 39. When was its use discontinued?

*A*. Several years ago, I can't remember.

*xQ*. 40. What was this ingredient used for?

> Objected to as not within scope of the direct examination and as immaterial, and as apparently tending to disclose confidential matters.

*A*. As an experiment.

Signature and certificate wavied.

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BRIDGEPORT, Conn., Dec. 7, 1906.

Present—Mr. HOLDEN and Mr. MASSIE.

And thereupon CHARLES A. CHADWICK, a witness produced by defendant, having been first duly sworn, deposes as follows:

By Mr. Massie:

*Q.* 1. Please state your name, age, residence and occupation.

*A.* Charles A. Chadwick; age 58; residence Bridgeport, Conn.; occupation, foreman of the store department at the factory of the American Graphophone Co.

*Q.* 2. How long have you been connected with the store department of the American Graphophone Co.?

*A.* As near as I can recollect, in the neighborhood of fifteen years.

*Q.* 3. I hand you three papers connected together and endorsed (among other things) "Voucher No. M. 205." I call your attention to a rubber stamp in green, containing some figures in red ink, and the initials "C. A. C.," appearing on the second paper What does this indicate to you?

*A.* That indicates that the goods were received.

*Q.* 4. In whose hand writing are these initials "C. A. C.?"

*A.* My own handwriting.

*Q.* 5. Do you know what stamp that is?

*A.* I recognize the stamp. It is a stamp of my department.

*Q.* 6. I show you seven other vouchers endorsed with the following voucher numbers: G. 115, C. 86, D. 55, D. 174, E. 15, J. 28, and J. 286. In each of these papers appear what purport to be bills from Smith & Nichols, New York City, charging the American Graphophone Co. with amounts of Carnauba wax. On these bills I find rubber stamps containing (among other things) your printed name, followed by the initial E. Can you identify these stamps and this initial, and if so, what are they?

*A.* It is a stamp used by the store department to identify the receipt of goods, and the initial is a gentleman's by the name of Elwell.

*Q.* 7. Can you state, briefly, the course of business in your department with regard to the receipt of materials and the verifications thereof, and what records are kept of the same?

*A.* We receive the goods either by express or freight, they are weighed or counted as the particular goods require, and an entry is made in a receipt book. This receipt, with the memorandum of the goods, if there should be such, are sent to the receiving department under the charge of Mr. Elwell. He receives bills for the same, compares it with receipt of goods, and if found correct, passes it.

*Q.* 8. Have you any present recollection as to the receipt in your department of Carnauba wax?

*A.* I have received Carnauba wax at various times.

*Q.* 9. Is it the custom of your department to put on bills the stamps we have been inquiring about before the goods have been actually received and counted or weighed? *A.* I should say not.

*Q.* 10. Are you willing to state positively, in view of these vouchers I have shown you, that on or about the dates of the several vouchers, the amounts of Carnauba wax therein recited, were actually received here at the Graphophone Co.?

*A.* Yes, sir.

*Q.* 11. Is there any objection to complainant's counsel examining the records of your department that show the original entries relating to the receipt of Carnauba wax?

*A.* So far as I know there is none.

Deposition closed subject to objections and cross-examination.

No cross-examination.

And thereupon HERBERT W. ELWELL, a witness produced by defendant, having been first duly sworn, deposes as follows:

By Mr. MASSIE.

*Q.* 1. Please state your name, age, residence and occupation?

*A.* Herbert W. Elwell; age 36; Stratford, Conn.; receiving clerk for the factory of the American Graphophone Co.

*Q.* 2. I hand you seven vouchers respectively endorsed as follows: C 86, D 55, D 174, E 15, G 115, J 28, and J 286. In these vouchers are what purport to be bills rendered the American Graphophone Co. by Smith & Nichols of New York City, for various amounts of Carnauba wax; and on said bills appear the marking of a rubber stamp bearing the printed name "C. A. Chadwick" with an initial. Please look at each of these stamps and state if you can identify the stamp and the handwriting of the initial?

*A.* I can. The stamp is one I have used, and the initial is my own.

*Q.* 3. What does the presence of this stamp with your initial indicate? *A.* It indicates the receipt of the goods.

*Q.* 4. Do these vouchers refresh your recollection so that you can remember that during the past year you actually received Carnauba wax? *A.* Yes.

*Q.* 5. These vouchers do not bear any dates later than the year 1903. Have you any recollection whether or not since 1903 and down to the present, you continued to receive Carnauba wax from time to time?

*A.* We have continued to receive Carnauba wax from then to the present time.

*Q.* 6. When you have received Carnauba wax in your department, what becomes of it?

*A.* It is sent to the foreman of the moulding and mixing department, he having previously supplied us with a want card or requisition calling for such wax.

*Q.* 7. Do you keep any records in your department showing the receipt of Carnauba wax or other raw material, and showing the delivery of portions of the same from time to time to the other departments of the factory?

*A.* We have a book acknowledging receipt of these goods, and a disbursement book showing disbursements to the factory.

*Q.* 8. Have you, within the last few days, examined this book with respect to the receipt by you of Carnauba wax, and its disbursement to the mixing and moulding department; and if you have examined the records for that purpose, what did you find?

*A.* In the book acknowledging receipt of the goods, I find entries of the bills covering the receipt of the goods covered by the vouchers which you previously handed me.

*Q.* 9. Have you any original receipts made by any of the employes of your department showing the receipt of Carnauba wax?

*A.* I have the original receipts with one exception, that of 1898, which covered the receipts of Carnauba wax on the vouchers which you have just handed me.

The witness produces eight receipts.

*Q.* 10. Where did you obtain these eight receipts that you now produce?

*A.* From records which I keep on file in the receiving department.

*Q.* 11. In whose handwriting is the bill dated Aug. 1, 1900?

*A.* To the best of my knowledge, in the handwriting of a man named Green who has since left the company.

*Q.* 12. And to the best of your present knowledge and opinion, in whose handwriting are the other seven?

*A.* I prefer not to identify the writing on the others.

*Q.* 13. I understand that your department acted upon these eight receipts you have just produced, by transferring the amounts noted thereon to the receipt journal. *A.* Correct.

Deposition closed subject to objections and cross-examination. No cross-examination.

Dec. 8, 1906.

Met pursuant to adjournment.

Present—Counsel as before.

And thereupon IRBY W. REID, a witness produced by defendant, having been first duly sworn, testifies as follows:

By Mr. MASSIE:

*Q.* 1. Please state your name, age, residence, and occupation?

*A.* Irby W. Reid; age, 33 years; residence, Bridgeport, Conn.; occupation, chief accountant for American Graphophone Company.

*Q.* 2. How long have you been chief accountant of the American Graphophone Co.? *A.* Since April 15, 1898.

*Q.* 3. Are you acquainted with a substance called carnauba wax; and if so, when did you first become acquainted with it?

*A.* I am; in December, 1898, or January, 1899.

*Q.* 4. Please state the circumstances under which you first became acquainted with carnauba wax?

*A.* For the purpose of figuring the cost of your product of cylinder records it was necessary for me to know the materials used in their manufacture, and by an official and special arrangement with Mr. L. Farini, who was in charge of the record manufacture, I was notified of first of the materials used and of any change that took place in the kind or quantity of those materials, under this arrangement I was notified by Mr. Farini of the use of carnauba wax by him during the month of December, 1898, either in that month or shortly after the close of the month which would be in January, 1899. I distinctly recall having Mr. Farini explain to me in what manner carnauba wax was used and to show me the material itself, which he did.

*Q.* 5. You were requested recently, for the purpose of this suit, to examine the records in your department with regard to the purchase of carnauba wax during the period since you have been in charge of that department. Please state briefly the result of your examination?

*A.* That the first purchase of carnauba wax was made in December, 1898, and various other purchases subsequent to that date.

*Q.* 6. Can you produce some of the vouchers relating to the purchase of carnauba wax by the American Graphophone Co. since you took charge of its accounting department?

*A.* I can produce a certified voucher and original bill of the supplier for all purchases of carnauba wax made by the American Graphophone Co. since April, 1898, and have already handed you eight of them.

*Q.* 7. I show you vouchers numbered respectively M205, G115, C86, D55, D174, E15, J28, and J286. Can you identify these various documents as genuine vouchers from the records in your charge? *A.* I can and do.

*Q.* 8. Please state briefly what the various papers in the batch endorsed M205 relate to; identify whatever signatures thereon you can; and tell us what the various stamps, entries, etc., thereon indicate, so far as you know?

*A.* Voucher M205 is based on Smith & Nichols bill of December 7, 1898, and their credit memorandum for bags returned of October 4, 1898. The number M205 designates that the voucher is for the month of December, 1898, and an indebtedness of the Company for that month, and was soentered. Smith & Nichols bill of December, 1898, referred to, covers 100 pounds carnauba wax at 16 cents per pound, $16.00. In the left-hand margin of this bill is given in red ink figures the number 12,303, which I idnetify as the number of the order placed by the purchasing department with Smith & Nichols for carnauba wax. This notation I identify as having been placed there by the purchasing department, on receipt of the bill from Smith & Nichols. I identify the signature, well known to me, of Mr. W. I. Starr, clerk in the purchasing department, as a certification that he had checked the prices and calculations on the bill. I identify the signature of Mr. C. March, purchasing agent, as a certification that the invoice was correct and due for payment A10, which signifies January 10. I identify the date, initials, and number written in the rubber stamp as follows:

"Goods received 12/8/98" —"
"Quantities
Certified correct C A C (179)"

as a notation made by the receiving department of the factory in Bridgeport, Conn., that the goods were received by them on December 8, 1898. That certification as to that receipt was made by the foreman of the receiving department, Charles A. Chadwick, and that a record of the receipt of the goods was made on page 179 in the regular official book kept for the purpose. I further identify the check mark (✓) and initial M as having been made by Mr. F. J. May, a clerk in the voucher department, as a further certification by the accounting department that the calculations were correct. I identify the number 36, written in pencil in the lower left-hand corner of this bill as having been placed there by myself to indicate to the general book-keeper, Mr. E. N. Stone, whose duty it was to make the voucher for that bill that the goods were to be charged on his book to account number 36, or "supply department." I identify the handwriting on the voucher-form (as distinct from the Smith & Nichols bill) with the exception of the signatures thereon, as that of Mr. May. I identify the signature of Mr. E. N. Stone at that time the general book-keeper, that the indebtedness as set forth by the voucher and accompanying invoices was correct and ready for approval of the president in regular course for payment. I identify the notation A25 C March as an indorsement made by the purchasing agent that the voucher should be paid on January 25. I identify the signature of Mr. H. A. Budlong in approval for the payment of the amount of the voucher. Mr. Budlong was and is the executive officer of the Company and his approval of this voucher was made for the president. I identify the receipt indorsement by Smith & Nichols.

No indebtedness of the American Graphophone Co. for goods received by the factory in Bridgeport has been paid since April 15, 1898, without a certification by the factory that the goods have been received in proper condition, a certification by the purchasing department indicating to the effect that the goods were regularly ordered for shipment to the factory, and without a certification on the voucher-form that the voucher is correct by the accounting department, and the approval of the president or his authorized representative.

*Q.* 9. Are you able, in like manner, to identify the various stamps, signatures, handwritings, initials, check marks, etc., on each of the remaining vouchers that have been presented to you this morning? *A.* I am.

Deposition closed, subject to objections and cross-examination.

No Cross-Examination.

Signature and certificate waived.

Counsel for defendant offers in evidence as Defendant's Exhibits the following U. S. Letters-patent:

Tainter No. 393,190, Nov. 20, 1888;
Tainter No. 421,450, Feb. 18, 1890;
Edison No. 406,576, July 9, 1889;
Macdonald No. 559,806, May 12, 1896;
Macdonald No. 606,725, July 5, 1898;
Macdonald No. 626,709, June 13, 1899;
Macdonald Reissue No. 12,095, March 10, 1903;
Macdonald Reissue No. 12,096, March 10, 1903.

Defendant's counsel also offers in evidence the letter to Mr.

Macdonald under date of Sept. 4, 1906, written by the witness Thornberry and identified by him, as "Defendant's Exhibit, Thornberry Report."

Defendant's counsel offers in evidence the four certificates of formula and temperature identified by the witnesses Thornberry, Cashman, Lynch, Tyler and Capron, as "Defendant's Exhibit, Thornberry Certificates 1, 2, 3 and 4."

Defendant's counsel likewise offers in evidence, as a physical exhibit, the thirty certificates of wear test, identified by the witnesses Thornberry, Capron and (by stipulation) Osborne and Belcher, the same to be marked "Defendant's Exhibit, Thornberry Wear Test Certificates."

Defendant's counsel offers in evidence the eight vouchers identified by the witnesses Chadwick, Elwell, and Reid, and the same are respectively identified as "Defendant's Exhibit, Voucher No. M 205; G 115; C 86; D 55; D 174; E 15; J 28; J 286."

Defendant's counsel asks that these vouchers may be returned, without being filed in Court, since they constitute part of the permanent records of the American Graphophone Co.

Defendant's counsel offers in evidence the eight original receipts produced by the witness Elwell, on the ground that the same were produced from the regular records of the American Graphophone Company, and had been acted upon by the Company in its regular course of business. The same are offered in evidence as a physical exhibit, as "Defendant's Exhibit, Original Receipts"; and defendant requests that the same may be returned to the American Graphophone Company, without being filed in Court, as constituting part of the permanent records.

Defendant's counsel states that the Thornberry Note Book, concerning which that witness has been examined, will be produced for inspection by defendant's counsel for the purpose of cross-examination, and in Court if desired; but as this Note Book contains entries of a confidential nature relating to other experiments disconnected with this work, of course, such other parts will not be exposed to inspection.

In like manner, the book produced by the witness Farini will be offered for inspection, under this same limitation.

So also the book produced by the witness Chadwick will be offered for inspection, under the same restrictions.

Adjourned subject to notice.

Raymond R. Wile Research Library

BRIDGEPORT, Conn., Dec. 19, 1906.

Met pursuant to agreement.

Present—Mr. DYER and Mr. MASSIE:

At request of defendant's counsel, complainant's counsel stipulates that the eight receipts produced by the witness Elwell recite the receipt from Smith & Nichols of carnauba wax, and correspond in date and amount with the vouchers concerning which the witness Reid and others have testified. And that the said receipts may be returned to the defendant.

It is further stipulated that the eight vouchers concerning which the witness Reid and others were examined purport to show sales of carnauba wax to the American Graphophone Co. by Smith & Nichols; and that these vouchers, heretofore offered in evidence, may in like manner be returned to defendant.

At the request of defendant's counsel it is further stipulated for the purpose of this suit that if the proper official of Smith & Nichols, of New York City, were produced as a witness for defendant, he would testify that, beginning about April, 1903, his house sold carnauba wax to the American Graphophone Co. in substantial amounts, and substantially as shown by the Farini book; that the sale of carnauba to the American Graphophone Co. has continued down to the present time; and that, prior to 1903, his house had furnished carnauba to the American Graphophone Co., in smaller quantities, and from time to time.

The signatures and certificates of the other witnesses examined at Bridgeport are waived.

Defendant's counsel offers in evidence the testimony given by David A. Dodd in a suit pending in this Court, entitled American Graphophone Co. against National Phonograph Co., March Term, 1906, in equity No. 11,—specifically the first three questions, question 24, and the cross examination. The same is identified as "Defendant's Exhibit, Dodd Deposition."

Defendant's counsel likewise offers in evidence "Defendant's Exhibit, Edison Patent 400,648, April 2, 1899."

Adjourned subject to notice.

In the Circuit Court of the United States for the District of New Jersey.

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| NEW JERSEY PATENT COMPANY<br>*vs.*<br>COLUMBIA PHONOGRAPH COMPANY, GENERAL. | In Equity, No. 12,<br>March Term,<br>Aylesworth Patent<br>No. 782,375. |

Testimony for final hearing taken on behalf of defendant at the offices of Messrs. MAURO, CAMERON, LEWIS & MASSIE, No. 620 F St., N. W., Washington, D. C., before WILLIAM B. KERKAM, Esq., a Notary Public, acting as Special Examiner by consent, under the Statutes and Rules of this Court, commencing January 15th, 1907.

Met pursuant to agreement.

Present—FRANK L. DYER, Esq., for Complainant; PHILIP MAURO, Esq., for Defendant.

Thereupon FREDERICK A. HOLTON, a witness produced by defendant, having been duly sworn, testifies as follows, in answer to interrogatories propounded by Mr. MAURO:

*Q.* 1. Please state your name, age, residence and occupation.

*A.* My name is Frederick A. Holton; age 47; residence, Washington, D. C.; and I am engaged in the preparation and prosecution of applications for patents, especially in the arts of chemistry and electro-chemistry, and Professor of Analytical Chemistry in the National College of Pharmacy of George Washington University.

*Q.* 2. Professor, please state what your education and experience have been that would qualify you to testify as an expert in this case, and particularly in relation to the chemical questions that arise therein?

*A.* I was educated at Cornell University from which I graduated in the course of Chemistry and Physics in 1883, and was, on graduation, appointed instructor in the chemical laboratory of that University, in which position I remained for three years. I was afterward an instructor in the same subject in the chemical laboratory of the Iowa State University, and for the past fourteen years I have been a professor of chemistry at the National College of Pharmacy, now a college of the George Washington University, of Washington, D. C. I was for a number of years an Assistant Examiner in the United States Patent Office, where my time was exclusively employed in examining and reporting upon applications for patents relating to chemical, metallurgical and electro-chemical subjects. Since severing my connection with the Patent Office, I have been engaged in the preparation and prosecution of patent applications, particularly in the arts referred to, and have repeatedly testified as an expert in patent causes. I am a member of the American Chemical Society and of the American Electro-Chemical Society.

*Q.* 3. Please state what you understand to be the invention described in the patent in suit and defined in claims 1 to 10 inclusive, and claims 12, 14, 16, 18, 19, 20 and 22.

*A.* The subject-matter of the alleged invention of the patent in suit is a composition of matter for making duplicate sound-records by use of a matrix or mold, and the patentee states that the desirable properties or characteristics of the composition are such that it may be effectively utilized in the manufacture of such records obtained by means of any process wherein the material, in a molten or plastic condition, is introduced into a matrix or mold and is allowed to set or is expanded therein so as to take an impression, and removed by diametric shrinkage sufficient to clear the engaging surfaces.

The patentee sets forth a large number of peculiarities which, it is alleged, such compositions should possess, and which he says he has secured. Without reciting the list of peculiar properties set forth in the patent, it will perhaps conduce to clearness if I first proceed to a statement of the method or formula employed by the patentee in the production of the alleged novel composition of matter. The patentee states that he employs certain ingredients in the proportions as follows, to wit:

| | | |
|---|---|---|
| 1. Commercial steric acid (a mixture of stearic and palmitic acids) | 100. | lbs. |
| 2. Recrystallized sodium carbonate | 21.5 | lbs. |
| 3. Caustic soda, 452 grams | .996 | lbs. |
| 4. Metallic aluminium, 175 grams | .385 | lbs. |
| 5. Carnauba wax | 21.36 | lbs. |
| 6. Ceresin | 21.36 | lbs. |
| 7. Lamp black, .9 to 3 per cent. | | |
| 8. Water, 10 gallons. | | |

The patent directs that these ingredients be incorporated in the following manner, to wit.: Melt 100 lbs. of stearic acid in a suitable galvanized iron vessel, at a temperature of about 240° F., then add to the melted stearic acid a water solution of carbonate of soda and aluminate of soda, made by dissolving 21.5 lbs. recrystallized sodium carbonate in ten gallons of water heated in a steam jacketed caldron, together with 452 grams (.996 lbs.) best caustic soda. When these ingredients are dissolved in the water, 175 grams (.385 lbs.) metallic aluminium are added and dissolved therein. This solution is filtered hot and is ready to be added to the melted stearic acid. The patent says that this solution is added cautiously to the melted stearic acid to avoid foaming, and the temperature of the mass gradually raised to keep pace with the increased melting point of the same. When all the alkaline solution has been added, the temperature will have run up to 360°F., and in the meanwhile water will have been driven off. At this point, 21.36 lbs. of "a very hard wax," preferably Carnauba, are added, and the mass is raised to about 450° F. and maintained until all foaming ceases, which the patent states usually takes about five hours. After the treatment of the molten material at the high temperature has been affected and all foaming has ceased, the patentee directs to add 21.36 lbs. ceresin and 9% to 3% of lamp black or other fine pigment. After the ceresin is added and incorporated, the congealing point of the mass may be regulated by addition of free stearic acid. "Where the congealing temperature is not important, no attention whatever need be paid to its regulation." The material is now strained and is ready for use.

Expressed in ordinary language, this means that the patentee first makes a metallic soap containing a certain amount of free stearic acid; second, for the purpose of hardening the metallic soap, he adds a "very hard wax," preferably Carnauba wax; third, for the purpose of rendering the composition non-hygroscopic and less brittle, he adds ceresin; and fourth, for the purpose of coloring the composition, he adds any suitable pigment.

As the equivalents of the ceresin, the patent mentions other non-hygroscopic waxes, such as paraffin or ozokerite, and as the equivalents to a greater or less extent of the Carnauba wax, beeswax, Chinese wax and palm wax are mentioned, though Carnauba wax is preferred.

After the Carnauba wax is added to the metallic soap mixture, the temperature of the mass is raised to about 450° F. and maintained until all foaming ceases, which the patentee states usually takes about five hours. The patentee appears to think that by thus heating the mass to about 450° F. after the Carnauba wax is added, a certain chemical reaction is obtained between what is vaguely referred to as "the alcohols of the Carnauba wax" and the free stearic acid in the metallic soap composition, and that as the result of this reaction between the vaguely mentioned "alcohols" of the Carnauba wax and the free stearic acid, there is formed a "hard wax-like compound ether which gives to the composition many of its desirable characteristics." In fact, the patent states that

> "unless the Carnauba wax is heated materially beyond its melting point, resulting in the reaction referred to taking place, the composition, although harder, is verry brittle, and shrinks excessively, and is therefore not so desirable as when the high heating is effected." (Lines 101 to 106, page 2.)

The melting point of Carnauba wax is about 184° F.

From these statements in the specification, it would appear that the patentee was ignorant of the chemical composition of the materials which he was employing. As a matter of fact, Carnauba wax itself is chiefly composed of a hard wax-like compound ether (myricyl cerotate), and a minute puantity of free alcohol (myricyl alcohol), so that when Carnauba wax is added to the metallic soap mixture, there is, in fact, added to the mixture without any reaction, a hard wax-like compound ether in a quantity depending upon the quantity of Carnauba wax added. It is barely within the range of possibility that the minute quantity of free alcohol contained in Carnauba wax might react under the temperatures mentioned upon some of the free stearic acid, so as to produce a very small additional quantity of wax-like compound ethers, but if this reaction does occur (and as to whether it does or not no scientific chemist is yet able to state authoritatively), the quantity of wax-like compound ethers thus produced is so minute as to be entirely negligible. Practically all the wax-like compound ethers introduced into the mixture by the formula set out in the patent are the compound ethers already existing in the Carnauba wax before it is added to the mixture, and they are wholly independent of the presence or absence of free stearic acid or any reaction whatever.

The whole statement in the patent as to the chemical theory by which the presence of the compound ethers in the resulting substance is accounted for, discloses to the mind of the truly scientific chemist the fact that the patentee was merely theorizing on the chemical properties of the substances with which he was dealing, and of the true actions of which he was ignorant.

Stript of the fallacious theory relating to the alleged reaction of alcohols in the Carnauba wax on the free stearic acid in the metallic soap composition for producing hard wax-like compound ethers, this step of the patentee's process comes down to the fact that a hard wax such as Carnauba wax, beeswax, Chinese wax or palm is added to the metallic soap for the purpose of hardening it.

In other words, the patentee had a metallic soap which he thought was not hard enough for his purpose, and he added a well-known hard wax, such as Carnauba wax, to make his composition harder.

Another reason set forth in the specication for subjecting the composition to a high temperature after the Carnauba wax is added, is that of avoiding the presence of decomposable products in the composition which, it is alleged, would affect the character of the composition and result in the production of bubbles in the surface of the molded duplicate. In other words, he submits the composition to a high enough temperature to "chemically char" all decomposable products in the composition, a step well-known for accomplishing this object in the treatment of these substances.

The ceresin wax or paraffin or ozocerite is added to the composition for rendering the mixture non-hygroscopic and less brittle than it would otherwise be.

Referring to the claims mentioned in your question, I find that claim 1 is for a composition of matter comprising metallic soap and a hard wax, while claim 2 is for the same, except that it specifies the hard wax as Carnauba wax. Claims 3 and 4 include another ingredient, viz., "a non-hygrocopic ingredient" (claim 3), which in claim 4 is specifically defined as ceresin. Claims 5 and 6 and for mere variations of composition defined in the previous claims. For instance, claim 5 calls for a metallic soap; Carnauba wax and a non-hygroscopic ingredient, while claim 6 is for the same, except that it specifies the non-hygroscopic ingredient to be ceresin.

Claim 7 is to all intents and purposes the same as claim 1. It is true that instead of calling for a composition of matter comprising a metallic soap and a hard wax, it calls for a mixture of a metallic soap and "a wax-like compound ether," but this "wax-like compound ether" in the claim is the equivalent of the "hard wax" of claim 1, or the Carnauba wax of claim 2, since it is by the addition of the Carnauba wax (or a hard wax constituting the equivalent thereof), that the "wax-like compound ether" is obtained in the mixture, for Carnauba wax is composed chiefly of a wax-like compound ether (myricyl cerotate). Claim 8 is the same as claim 7, except that it also includes the non-hygroscopic ingredient which in claim 9 is more specifically defined as ceresin. Claim 8 is broad enough to include not only ceresin, but the alleged equivalents mentioned in the patent, of paraffin and ozocerite as the non-hygroscopic ingredient.

Claim 10 is the same as claim 1, except for the element of a black pigment for the purpose of coloring. Claim 12 merely calls for the addition of a black pigment to the metallic soap and Carnauba wax of claim 2. Claim 14 is the same as claim 6, except that it adds a black pigment, while claim 16 is the same as claim 7 with the addition of the black pigment.

Claim 18 is the same as claim 3, except that the metallic soap is specified in claim 18 as a particular kind of metallic soap, viz., stearate of soda, while claim 19 corresponds to claim 5, except that the specific metallic soap, viz., stearate of soda, is defined, instead of the broad expression "metallic soap" of claim 5. Claim 20 is the same as claim 12, with the same exception, that is, it specifies stearate of soda rather than the broader expression "metallic soap." Claim 22 specifies a composition containing two specific metallic soaps, viz., stearate of soda and stearate of aluminium, to which the hardening wax "Carnauba wax" is added.

These several claims are but different ways of expressing the idea that a hardening wax, such as Carnauba wax, is added to the metallic soap composition that is produced by combining an excess of stearic acid with an alkaline solution containing aluminium; and the further idea that a tempering wax, such as ceresin, is also added, with or without a coloring pigment. These claims all define more or less specifically this composition of matter, resulting from the carrying out of these steps.

*Q.* 4. In answer to *Q.* 5, Mr. Aylesworth, the patentee, states that if Carnauba wax is added to a record composition containing free stearic acid, at a temperature of about 450° F., "the free myricyl alcohol of the Carnauba wax will combine with the free stearic acid to form a compound, known as ether, or compound ether." Please state how much, if any, "free myricyl alcohol" there is in Carnauba wax.

*A.* A trace only; not enough to be of any practical importance in the resulting composition.

*Q.* 5. What is the composition of Carnauba wax?

*A.* Carnauba wax chiefly consists of a wax-like compound ether, (myricyl cerotate), and a trace or minute quantity of myricyl alcohol.

*Q.* 6. What is the composition of palm wax?

*A.* Palm wax consists chiefly of two wax-like compound ethers, to wit, ceryl ceretate and myricyl palmitate. Investigators have failed to report the presence of free alcohol in this wax.

*Q.* 7. What is the composition of Chinese wax?

*A.* Chinese wax consists almost entirely of a wax-like compound ether, ceryl cerotate. The latest authorities on the composition of this wax fail to even mention the presence of free alcohol.

*Q.* 8. What is the composition of beeswax?

*A.* Beeswax consists chiefly of a wax-like compound ether, myricyl palmitate, and cerotic acid. The quantity of the former is about six times that of the latter in this wax. A small quantity of free myricyl alcohol has been reported as present by recent investigators, this body being so small; however, as to have been previously overlooked.

*Q.* 9. What chemical authority is there for saying that a wax-like compound ether will be produced by any reaction occurring between the materials of the composition of the patent in suit if there is no *free* alcohol in the "hard wax" that is added to the mixture? *A.* There is none.

*Q.* 10. Professor, in the answer to *xQ.* 49, Mr. Ayles worth in complainant's prima facie proofs states, in referring to the behavior of the ingredients when Carnauba wax is added.

> "I would not consider that the Carnauba is broken up by the process, but what takes place is that part of the Carnauba, the myricyl alcohol in a free state, combines with a part of the excess of stearic acid."

Please state your views on this matter.

*A.* I note in that part of Mr. Aylesworth's answer quoted in your question, two separate statements to wit: (1) "I would not consider that the Carnauba is broken up by the process." With this I agree. With the second statement, to wit, "what takes place is that part of the Carnauba, the myricyl alcohol in a free state combines with a part of the excess of stearic acid." I do not agree. The evidences of chemical union between the free stearic acid and whatever free myricyl alcohol present in the Carnauba, are far from convincing. I do, not, however, wish to assert that such combination of these two bodies in the composition of the patent is beyond the realm of possibility.

As I have before stated, the free myricyl alcohol in Carnauba wax is so small that it may be properly designated as a trace, and were it to unite with the free stearic acid of the soap mixture, the wax-like compound ether supposed to result would be inappreciable as compared to the quantity already existing in the Carnauba when added to the metallic soap mixture.

*Q.* 11. Please examine Mr. Aylesworth's answer to *xQ.* 75 in the same deposition, and note any corrections that should be made in his figures and formulas there given.

*A.* I find in Mr. Aylesworth's answer an error in the formula of "stearate of soda." The formula should read "$Na\ C_{18}\ H_{35}\ O_2$" instead of "$Na\ C_{18}\ H_{30}\ O_2$" as in his answer.

I further observe the statement in this answer that "3.8 parts by weight of $Na_2$ O will combine with and exactly neutralize 53.03 parts pure stearic acid the product being stearate of soda." This quantity 53.03 is too great. The parts by weight of stearic acid that are required to combine with 3.8 parts of sodium oxide $Na_2$ O, are 34.8 instead of 53.03, as stated in Mr. Aylesworth's answer, to form stearate of soda of the corrected formula $Na\ C_{18}\ H_{35}\ O_2$, and therefore, the total amount of stearic acid that will combine with 3.8 parts of sodium oxide and .7 aluminium oxide is $34.8+11.6=46.4$ parts, and this deducted from 71.8 parts, which Mr. Aylesworth says he found in these records, would leave 25.4 parts free stearic acid.

*Q.* 12. In the sound-record art, what do you understand is meant by the term "toughness?"

*A.* Toughness is the opposite of brittleness and may be developed by heat as described in Tainter's U. S. patent No. 421,450. Tainter describes boiling ozocerite wax, and thereby toughening it.

*Q.* 13. Defendant's exhibit, Edison patent No. 400,648 describes mixing 100 pounds of stearic acid with 25 pounds each of ceresin and beeswax, at their melting points. What is the melting point of each of these bodies?

*A.* Pure stearic acid melts at 156.5° F.; ceresin melts between 141.8 and 172.4 F., and beeswax melts about 145° F.

*Q.* 14. What reaction, if any, takes place between the free stearic acid and the beeswax when melted together as stated in the said Edison patent?

*A.* Beeswax contains, according to later authorities, a trace or small quantity of free alcohol. The combination of this alcohol and the stearic acid would make a wax-like compound ether. That such a reaction takes place is remotely possible. If beeswax contains no free alcohol, then no chemical reaction takes place.

*Q.* 15. Is it essential in order that the composition of the patent in suit should contain a wax-like compound ether, that there should be *free* alcohol in the "hard wax" entering into the composition?

*A.* It is not. Carnauba wax is chiefly composed of a wax-like compound ether. Chinese wax is nearly a pure compound ether; and beeswax contains as one of its chief ingredients a compound wax-like ether associated with cerotic acid, and these two constitutents make up nearly the whole composition of this wax. Palm wax, like the others, is chiefly composed of wax-like compound ethers. In fact, this wax is sometimes sold on the market under the name of Carnauba wax. More strictly speaking, Carnauba wax is one species of palm wax. In any event, these two waxes are so nearly alike in many of their leading characteristics, that the one can be used instead of the other. So that all of the "hard waxes" mentioned in the patent in suit are waxes whose chief constituent is a compound ether, and when any one of these waxes is added to the mixture, it is in fact adding a wax-like compound ether to the mixture, and this is entirely independent of whether there is any free alcohol in the added wax or not.

*Q.* 16. In his answer to *Q.* 5, Mr. Aylesworth gives as one of the evidences of the formation of a compound ether, his observation that when the Carnauba wax is added, there is an elimination of gas, causing the material to froth and foam. In your opinion, is this elimination of gas which causes the material to froth and foam as alleged, any proof of the formation of a compound ether? *A.* It is not.

*Q.* 17. Why not?

*A.* One of the phenomena frequently observed when chemical reactions occur as the result of the mixture of two substances, is an elimination of gas, causing the mixture to froth and foam, but such elimination of gas with its resulting froth and foam is by no means a conclusive proof that a chemical reaction is taking place, since there may be other causes for the elimination of the gas with resulting froth and foam, and no careful chemist will ever accept such frothing and foaming as proof of chemical reaction until he has carefully eliminated all other causes therefor. Now it is a fact which I have frequently observed in my own practice that when Carnauba wax alone and unmixed with any other substance is subjected to a high temperature, there results an elimination of gas which causes a violent frothing and foaming of the molten Carnauba wax. The elimination of gas from the molten Carnauba wax which results in this frothing and foaming may be due to several causes. Thus, the increased temperature will result in the elimination of the contained moisture and air in the wax, and this alone would be sufficient to produce frothing and foaming. Moreover, when any considerable body of metallic soap such as mentioned in the patent, has Carnauba wax added thereto, and the whole is heated so as to raise the temperature of the mass to 450° F., those parts at the bottom of the containing vessel, and therefore closest to the heat, are liable to have a temperature so high as to volatilize some of the constituents or cause the disassociation of the compounds, with the resulting production of gas which would rise through the mixture and cause the frothing or foaming.

For these reasons I can confidently assert that to a careful scientific chemist frothing and foaming occurring upon the addition of Carnauba wax to the metallic soap mixture under a temperature of 450° F., is by no means proof of a chemical reaction, and on the contrary, since the Carnauba wax alone froths and foams when heated to a high temperature, the fact of such frothing and foaming when it is added to the metallic soap at a high temperature, is worthless as evidence of any chemical reaction occurring, and still less is it evidence of the formation of a compound ether.

*Q.* 18. As a further evidence of a chemical reaction resulting in the formation of a compound ether upon the addition of Carnauba wax to the compound containing free stearic acid, Mr. Aylesworth mentions "the different nature of material which is produced if Carnauba wax is added to stearate of soda composition, containing an excess of stearic acid, where the temperature is not raised sufficiently to cause such combination to take place." Please state if the different nature of material which is alleged to be here effected by addition of Carnauba wax accompanied by heating, would be an "evidence" of the chemical combination of its stearic acid and the free myricyl alcohol, giving your reasons for any conclusions you may reach.

*A.* It would not. By the very nature of things, the incorporation of a hard wax, like Carnauba wax, with a softer composition like that of the metallic soap mixture in the presence of a high temperature, will cause a change in the physical nature of the material, even in the absence of any chemical reaction. The mere heating of such a mixture in itself causes an elimination of water, always present in the wax, thereby enabling the particles or molecules of the mixture to come nearer within the sphere of each other's attraction, and hence form a more intimate and more coherent mass, and the extended time during which the heating takes place (about five hours) contributes materially to emphasize this change in the physical characteristics of the material wholly independent of any chemical reaction. This physical change alone would cause the molded composition to offer greater resistance to the wearing action of the stylus.

The effect of heat in causing an increased toughness in a wax is well known. For example, in defendant's exhibit, Tainter patent No. 421,450, it is expressly stated that "After concentration by boiling it becomes harder and tougher." A mere physical change in a substance is not of itself evidence of a chemical change therein, and a skilled chemist would not conclude from observing a physical change in such a complex composition as that of the patent in suit, that a specific chemical reaction had taken place between free alcohol in the Carnauba wax and the excessive free stearic acid in the soap

*Q.* 19. As a still further evidence of the formation of a compound ether upon the addition of Carnauba wax to the compound containing free stearic acid, Mr. Aylesworth mentions "the results of the analyses." Do you find anywhere in the evidence in this case any analyses or analysis which prove that a compound ether is formed by the combination of free myricyl alcohol of the Carnauba wax with the free stearic acid of the compound?

*A.* I do not. The analysis referred to gives 71.8 per cent. as the total stearic acid found in the molded record. It gives no information respecting the amount alleged to be combined with the alcohol in the Carnauba, and this analysis gives no data whereby such quantity may be found by calculation.

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WASHINGTON, D.C., Jan. 21, 1907.

Met pursuant to agreement.

Present—FRANK L. DYER, Esq., for Complainant; REEVE LEWIS, ESQ., for Defendant.

(MR. DYER proceeds with the cross-examination of Mr. HOLTON):

*xQ.* 20. You are connected, I believe, with Philip Mauro, Esq., solicitor and counsel for defendant herein? *A.* I am not.

*xQ.* 21. Your name appears on the door of his office in Washington, does it not? *A.* It does.

*xQ.* 22. What if any experience have you had in connection with the manufacture of compositions for phonograph records?

*A.* I have had no practical experience in the manufacture of phonograph records.

*xQ.* 23. Your experience is based entirely on what you have read in patents and literature?

*A.* My experience is based on the study of patents, of literature, and upon laboratory experiments.

*xQ.* 24. You never witnessed the manufacture of these compositions then?

*A.* I have not; not in the factory.

*xQ.* 25. Are you familiar with the practical art of making molded records?

*A.* I am more or less familiar with the art as practically expressed in patents.

*xQ.* 26. But not as it is carried out commercially? *A.* No.

*xQ.* 27. I understand that you appear in this case as a patent expert, skilled in chemical matters. Is that correct?

*A.* I have had considerable experience with patents and with chemistry, and am entitled to state that I am an expert in those lines.

*xQ.* 28. You undertake, however, to explain, as I understand it, to the Court the substance of the patented invention and the meaning of the claims of the patent in suit? *A.* I do.

*xQ.* 29. Do you agree with the statements of the patent in suit as to the desirable properties that a sound-record material should have in order to fit it for the practice of this particular art?

*A.* Whether all of the properties alleged to be requisite for a record composition as enumerated in this patent are essential or not, I have made no investigation for the purpose of determining in each case.

*xQ.* 30. You are not able to say, then, whether a composition which was lacking in one or more of the peculiarities set forth in the patent in suit would be suitable for the practice of the art?

*A.* I am prepared to state that if such a composition lacked hardness, which is one of the peculiarities mentioned, it would not be suitable.

*xQ.* 31. So far as you are able to state, then, a composition which possessed hardness but possessed none of the other peculiarities set forth in the patent in suit might be a suitable composition for the practice of the art?

*A.* I can hardly imagine a substance having only one property, and that hardness.

*xQ.* 32. Can you say, then, what of the peculiarities in addition to hardness that are set forth in the patent in suit you regard as necessary in a suitable composition for making molded records?

*A.* Such composition would require the property of capability of becoming molten when heat is applied to it. It should be free from bubbles when in a solid state. Its texture should be fine. It should be hard. When it passes from the liquid to the solid state it should not crystallize. It should not adhere to the mold. It should have a certain amount of shrinkage. Its texture should be sufficiently fine to give a smooth surface. It should not deteriorate because of moisture. It should have a sufficiently high melting point so as not to become destroyed in hot localities by being melted down. Its color is a matter of choice. Those at least are desirable properties which, I understand, a composition should possess.

*xQ.* 33. You agree with me, I suppose, that the greater the limpidity of the composition in the molten state, other things being equal, the sharper would be the impression received from the mold. In other words, a limpid composition would take a sharper impression than a viscid composition?

*A.* The term "limpid" means *clear,* and as I understand the term does not apply to the degree of fluidity. However, a composition in a fluid condition would flow more readily into intimate engagement or contact with the record service than if it were merely plastic.

*xQ.* 34. Would you not also consider it a very desirable property of a successful molded record composition that it should not shrink away from the mold until its surface was quite hard, as set forth in the patent in suit?

*A.* As I have previously stated I have had no practical experience with reference to the congealing of a sound record composition, and have not studied its characteristics in this regard. What the patent states with respect to this, I am not prepared to state whether it is or is not true.

*xQ.* 35. Aside from the patent in suit, and from your inexperience in the practical art, would you not consider, as a scientific chemist, that a composition which was of such a nature that, when made into a molded record, would not shrink away from the mold until the surface was quite hard, would necessarily be superior to one in which the shrinkage took place when the surface was less hard?

*A.* A composition that would begin to shrink away when its surface in contact with the mold was soft would, in my opinion, take a less sharp impression away with it than if that surface were hard and its part rigid when it left the surface of the mold. This, however, is answered without having tried the experiment.

*xQ.* 36. Do you not consider that uniformity of surface or, in other words, absence of warping, is an important peculiarity or characteristic that should be possessed by a successful molded record composition?

*A.* I would say that warping would not be a desirable property in such a composition when it sets.

*xQ.* 37. You are aware, are you not, that in the modern molded record art, as practiced by complainant and defendant, the records are eitther wholly or largely finished on their interior while the record is still tightly engaging the mold and before the phenomenon of diametric contraction takes place?

*A.* Personally I do not know whether that is the fact or not.

*xQ.* 38. You do not know, then, that it is largely because of that fact that it becomes so desirable to make a composition that shrinks uniformly and without warping?

*A.* I do not know, though I do not understand that such would necessarily follow.

*xQ.* 39. And therefore I suppose you would not be able to say that a desirable molded record composition should be one in which the material can be smoothly cut on the interior while hot, as set forth in the patent in suit?

*A.* As I understand, the surface of the interior is of a more or less roughened character even when finished, and whether the surface be smooth or not is not so material, and for this reason it is not so essential that the material should be sufficiently plastic to facilitate cutting on the interior surface as it would be where the outer surface was to be trimmed.

*xQ.* 40. Have you ever examined the molded records made by complainant and by defendant to determine whether the interior surface was more or less rough?

*A.* I have examined molded records of the defendant, purchased on the open market, and I have noticed that the interior surface was more or less rough.

*xQ.* 41. Did you examine the molded records made by defendant at the present time in which the bore is provided with a series of concentric ribs, or have you in mind the molded records first manufactured by defendant in which the bore was provided with a continuous spiral rib?

*A.* The ones that I examined had concentric ribs, as I remember now.

*xQ.* 42. And you regard the interior of those records as being rough, as I understand you?

*A.* Rough is a relative term, but an examination of their surface gave to me the impression not of smoothness but more or less roughness.

*xQ.* 43. Did you ever examine one of the defendant's first molded records in which the bore was provided with a spiral rib, to determine whether or not the interior surface was rough?

*A.* I have not.

*xQ.* 44. As to this capacity of the patented composition to permit of its being cleanly cut while hot, you are familiar I presume with many materials and compositions which while hot cannot be cleanly cut, but in which the material will drag after the cutting knife?

*A*. The term "hot" is rather an indefinite expression. Whether or not a given substance would drag under the action of the cutting knife would depend partly upon the temperature and partly upon the nature of the composition itself. I can readily imagine that certain substances would drag under the cutting knife and others would not.

*xQ*. 45. As I understand your position, it is that Mr. Aylesworth has simply taken a metallic soap, added ceresin thereto to make it non-hygroscopic and less brittle, and then introduced carnauba wax for the purpose of hardening the metallic soap. Is this the only purpose of the carnauba wax, as you understand it? I of course have reference to the invention of the patent in suit.

*A*. It is.

*xQ*. 46. That being so, why could not any material be added to the metallic soap that would have the property of making it harder?

*A*. I understand that beeswax, Chinese wax and palm wax, as stated in the patent, may be substituted for carnauba wax.

*xQ*. 47. But if the sole purpose of the carnauba wax is to make the composition harder, why could not any hardening ingredient be added to the metallic soap to make a desirable composition?

*A*. When I state that carnauba wax is added for the sole purpose of hardening, it is to be understood that this property alone connot exist by itself, but that the carnauba wax has the capability of becoming molten and miscible with the other ingredients. There might be other hardening agents added, such as sand or ground rock, but they obviously would not be miscible and form a molten composition which could be moulded.

*xQ*. 48. From your point of view, then, in selecting a hardening ingredient for a molded record composition, it is necessary to choose one which of itself may be molded and will become miscible with the other ingredients of the composition?

*A*. It must be one which at least can become molten under the conditions of operation. It may not, however, be one which could be successfully molded itself.

*xQ*. 49. Assuming that the metallic soap, with the addition of ceresin, possesses some of the desirable peculiarities that a successful molded record composition should have, then is it not also a fact, from your point of view, that in selecting a desirable hard-

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ening ingredient we should choose one which would not destroy or alter the desirable properties possessed by the metallic soap?

*A.* It is evident to me that a hardening agent should not destroy the properties found desirable in the composition of a molded record. When, however, such a composition lacks one of the desirable properties, such as hardness, then selection of the substance should be so made as to introduce this property, and to this extent alter the property of the resulting composition.

*xQ.* 50. The metallic soap composition, to which you refer, in answer to question 3 is, as I understand it, a mixture of free stearic acid, stearate of soda and stearate of aluminium. Is this correct?

*A.* This refers to the composition resulting from reacting on the stearic acid with the carbonate of soda, caustic soda and aluminium dissolved in the caustic soda. The result of this reaction is that the composition referred to contains excess of stearic acid, a metallic soap, sodium stearate and aluminium stearate, so that I will answer your question in the affirmative.

*xQ.* 51. Now assume that to such a composition is added substantially the proportion of ceresin set forth in the patent, and it is found that the resulting mixture possesses some of the properties that a desirable molded record composition should have, especially its absence from decomposition products, the smoothness of its surface and the peculiarities of passing from the liquid to the solid state through a condition of gradually reducing plasticity. That being so, in selecting a hardening ingredient for addition to such a mixture, is it not important that we should choose a material which did not alter these desirable properties already possessed by the metallic soap—ceresin mixture?

*A.* A metallic soap composition, containing free stearic acid and ceresin, possesses substantially all of the desirable characteristics of such a mixture when made under the conditions of temperature stated in the patent in suit, except that it lacks hardness. In selecting a hardening agent, therefore, it is desirable that properties which have already been found advantageous in such a mixture should not be destroyed by the addition of the hardening agent.

*xQ.* 52. Upon what experience or knowledge in the art do you base the statement made in the last answer, that

> "A metallic soap composition, containing free stearic acid and ceresin, possesses substantially *all* of the desirable characteristics of such a mixture when made under the conditions of temperature stated in the patent in suit, except that it lacks hardness." (Italics mine.)

*A.* I base my reply on knowledge derived from Defendant's Exhibit, Macdonald Patent No. 626,709, which describes a metallic soap composition to which paraffin or ozocerite has been added, which are substantial equivalents of ceresin. My knowledge is also derived from Defendant's Exhibit, Macdonald Patent No. 606,725.

*xQ.* 53. Do you find any statement in either of these Macdonald patents that the compositions described therein are to be used for, or are suitable for, the manufacture of molded records?

*A.* I find in Macdonald, No. 606,725 that the composition is capable of being molded, on page 2, line 71, although the patent states that the invention relates to the manufacture of tablets or blanks adapted to receive engraved records of sound. Patent No. 626,709 also states that the invention relates to the art of manufacturing blanks or tablets upon which sound records may be cut or engraved. The compositions described in these patents contain a metallic soap, an excess of stearic acid and ceresin, and the product is not as hard as would be the case if a hard wax, such as carnauba wax, were added thereto, though these compositions are capable of being molded, as the patent states.

*xQ.* 54. What statements do you find in these two Macdonald patents that enables you to say that the compositions described therein possess substantially *all* of the peculiarities of the composition of the patent in suit, except the quality of hardness?

*A.* I am not prepared to say that all the characteristics set forth in this patent in suit are desirable characteristics for the reason that I have not experimented to determine all these characteristics. I do mean to say, however, that the compositions set forth in Defendant's Exhibit, Macdonald Patents No. 626,725 and No. 626,709 possess substantially all of the desirable characteristics of a successful record composition except that of hardness. For example, these compositions are capable of being melted into a fluid state and capable of being poured into molds. Their texture is amorphous and non-crystalline. They are free from decomposition products, such as might result from the decomposition of fibrous material in the ingredients. These compositions being amorphous would of necessity be of fine texture or grain. They are capable of being molded and as these materials have a certain amount of contraction on cooling, the composition can be readily removed from the mold. In view of the fact that they contain paraffin or ozocerite, the equivalent of ceresin, they have the characteristic of not being affected by moisture. These compositions are capable of being cleanly cut, for patent No. 606,725, lines 13–20, page 1 state:

> "The recording material in order to answer well the requirements of the engraving method of recording sounds should be perfectly amorphous, slightly cohesive, and capable of being removed cleanly and smoothly in chips or shavings under the action of the recording-stylus when actuated by the feeble force of sound-waves."

Adjourned for lunch.

(Answer continued):

From my general knowledge of the properties of plastic compositions, I am of the opinion that the compositions set forth in the Macdonald patents referred to are capable of being molded and are capable of taking sharp impressions.

*xQ.* 55. You do not mean to claim, do you, that at the date of the two Macdonald patents the molded record art was known or that those patents were intended to describe anything more than suitable compositions from which blanks could be molded, and on which the records would be directly cut by the recording stylus?

*A.* I do not know when the molded record art began.

*xQ.* 56. Then you are not able to answer the latter part of my question as to the particular purpose for which the compositions of the Macdonald patents were designed to be used for?

*A.* The patents to Macdonald referred to state that the inventions relate to tablets or blanks adapted to receive engraved records of sound, but from my knowledge of the plastic materials entering into such composition I do not hesitate to express my opinion that these compositions are capable of being molded and taking impressions. They, however, would not be as hard as they might be made for the reason that the ingredients entering into them are not as hard as, for example, a hard wax, like carnauba wax.

*xQ.* 57. But, as I understand it, aside from the quality of hardness, you are of the opinion that the compositions of the Macdonald patents possess all the desirable properties for the making of molded records that is possessed by the composition of the patent in suit?

*A.* As I previously stated, there are characteristics of the patent in suit, such as limpidity, and dark color which may not be essential characteristics, and it would not be necessary that the composition should be limpid or clear, as I understand the term, or should have a dark color in order to be successfully molded. The Macdonald compositions are certainly capable of becoming liquid or molten. They have, for example, amorphous structure, fine texture, are capable of contracting, capable of resisting moisture, and it is my opinion, based on my general knowledge of plastic materials, that ceresin wax is capable of enabling to a more or less extent of passing from the liquid to the solid state through an intermediate condition of gradually reduced plasticity. This latter statement is made, however, without having actually made the test myself. The Macdonald compositions do possess the essential characteristics of a molded record composition, although they may or may not comply with all the numerous characteristics specified in the Aylsworth patent in suit.

*xQ*. 58. You state that the compositions of the two Macdonald patents do not comply with the specification of peculiarities of a desirable molded record composition, as set forth in the patent in suit, so far as limpidity, hardness, and color are concerned. What other peculiarities or characteristics that are set forth in the patent in suit as desirable in a molded record composition, whether you consider them desirable or not, are absent in the compositions of the Macdonald patents? By limpidity I have reference to the capacity of readily flowing into engagement with the mold, rather than clearness.

> Mr. Lewis—Applying the meaning of limpidity as specified in the last part of the question, to counsel's statement as to what the witness has testified to, as given in the first part of the question, the substance of the witness' testimony has not been correctly stated as it is understood by counsel for defendant. The question is therefore objected to on this basis as improper.
>
> By Mr. Dyer—Attention of counsel for defendant is directed to answer to *xQ*. 33, from which it seems reasonably clear that the witness understands the term "limpid" as used in the patent in suit to relate to fluidity. That is the sense in which the word is used in the question.

*A*. In my answer to *xQ*. 57 I stated

> "there are characteristics of the patent in suit such as limpidity and dark color which may not be essential characteristics, and it would not be necessary that the composition should be limpid or clear, as I understand

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> the term, or should have a dark color in order to be successfully molded." The Macdonald compositions certainly capable of becoming liquid or molten."

The term "limpid" refers to clearness and does not refer to the property of becoming liquid or molten. The Macdonald patents therefore disclose a composition capable of becoming liquid. The Macdonald compositions, however, although possessing a certain degree of hardness, as all compositions do, yet they lack that degree of hardness which is imparted to them by the addition of a harder substance, such as carnauba wax. With respect to the color, I understand that this is a matter of choice and is not an essential characteristic as, for example, as the quality of hardness would be.

*xQ.* 59. As I understand your position, it is that with the exception possibly as to limpidity and certainly with regard to hardness and color, you find that the compositions of the Macdonald patents contain substantially all the desirable peculiarities that are set forth in the patent in suit as characterizing the molded record composition described therein. I have felt that in referring to "desirable" characteristics there might be other characteristics which you did not consider desirable that might not be possessed by the Macdonald compositions, and yet might be referred to in the patent in suit. Therefore what I want to obtain from you if possible is whether, aside from these peculiarities, the compositions of the Macdonald patents contain all the characteristics that are set out in the patent in suit, whether you consider them desirable or not?

*A.* The Aylsworth patent states that certain peculiarities should be possessed by the record composition. Two of these characteristics, to wit, limpidity or clearness (and by limpidity I do not mean the capability of becoming liquid but use the term in a dictionary sense to mean clearness) and the peculiarity of color are characteristics which are not vital to the composition. Limpidity, however, as counsel for complainant understands the term to mean liquidity—in that sense limpidity is essential. All the other characteristics specified in the Aylsworth patent in suit, except hardness, are substantially found in the compositions of the two Macdonald patents. I have reached this conclusion, not from my practical knowledge of the compositions of the Macdonald patents, but from my knowledge largely obtained by experiment and from a study of the substances entering into these compositions.

*xQ.* 60. I do not understand that you have ever experimented with the compositions of the Macdonald patents as a whole, but only with the ingredients entering into their make-up?

*A.* I have studied the characteristics of the ingredients entering into their make-up, and have commingled these ingredients and have gained more or less information from such compounding of the ingredients.

*xQ.* 61. But I understand that you have never experimented with the complete compositions of these patents?

*A.* I have not.

*xQ.* 62. In your answer to *xQ.* 59, you state that certain characteristics of the patented composition are "substantially found" in the compositions of the Macdonald patents. How much latitude do you give to the word "substantially"? I ask this because we are dealing with an art that relates to more or less careful work and rather delicate consideration.

*A.* The peculiarities or characteristics which are enumerated in the patent in suit are physical characteristics, and like physical characteristics vary more or less with the relative quantities of the ingredients. These characteristics are not, like the characteristics of a definite chemical compound, which have less latitude of variation, and by the term "substantially" I mean such a latitude of variation in the matter of fluidity, of texture, of shrinkage, etc. which such a composition could have without destroying its utility for its purpose as a sound record.

*xQ.* 63. The test, then, which you applied is utility, as I understand it?

*A.* The test which I would apply is whether or not it produces an operative sound record.

*xQ.* 64. Would you not also consider as elements entering into the question of identity or substantial identity of two compositions, the fact of the time required to preduce the records from the several compositions under the same conditions, the quality of the surface of the resulting records, the character of the shrinkage so far as the number of threads per inch are concerned and the condition of concentricity of the record, as made from the several compositions?

*A.* In responding to your question, I find it necessary to answer the several points referred to categorically. The question states, first, would you not also consider "as elements entering into the question of identity or substantial identity of two compositions the fact of the time required to produce these records from the several compositions." It is my understanding that the identity of a composition is independent of the method of making

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it. If the process of manufacturing of the records was in question it might be necessary to consider this step of the process. Second, the number of perfect records which could be made from the several compositions under the same conditions might, or might not, be a guiding characteristic respecting identity of compositions. If, for example, the number of perfect records differed materially such fact might be attributable to an inherent difference in the compositions. If the number of perfect records did not vary materially the explanation might be found in the fact of personal error, because in carrying out any experimental work of tests it is extremely difficult to do two things alike at different times. Third, "the quality of the surface of the resulting records" might or might not point to identity of two compositions. The same composition might have differences of quality of the surface in which case there would be no question of identity of compositions because it would be one and the same composition. For example, the quality of the surface depends upon the physical characteristics of the composition which have variable characteristics under variable conditions. Fourth, I am not able to answer with any degree of certainty respecting the statement in the question, to wit, "the character of the shrinkage so far as the number of threads per inch are concerned and the condition of concentricity of the record." I have had no practical experience with respect to these characteristics.

*x*Q. 65. I think possibly you have misapprehended my question, and I will try to make my position clear. As I understand it, you state that in your opinion except as to the three peculiarities which we have already discussed, the compositions of the Macdonald patents are substantially the same as the composition of the patent in suit. In order to determine whether the two compositions are substantially the same you apply the test of utility, or, in other words, you say, in answer to *x*Q. 63, that the test would be whether from the different compositions you could produce "an operative sound record." Now, I ask if in addition to this bald matter of utility or operativeness you should not take into consideration in determining the substantial identity of the several compositions the other considerations to which I have referred in *x*Q. 64. In other words, assume that under identical conditions of manufacture we attempt to make molded records of the compositions of the Macdonald patents, and under identically the same conditions of manufacture we attempt to make molded records of the patented composition, and in order that that the element of human error may be minimized as much as possible we make a large number of these experiments all relating in substantially the same results. If, as a result of such experiments, it were determined to your own satisfaction that with one composition very much better results could be obtained than with the other, both as to the ease with which the process might be carried out and the quality or character of the finished records, would you not take those facts into consideration in determining the identity of the several compositions? *A.* Yes.

*xQ.* 66. Would you consider the following materials hardening ingredients if admixed with the metallic soap, ceresin composition that is formed by the process of the patent in suit if the carnauba were omitted, viz., asphalt, carnauba, metallic soap, celluloid, glue, resin, rubber stearic acid, magnesium palmitate, gum balata, gun cotton, ebonite, lead stearate, magnesium stearate, aluminum stearate, plaster of Paris, shellac, sand, sawdust, guttapercha, sealing wax, stearate of soda, vulcanite, chromatized gelatine, rosin, colodion, chalk, slaked lime and lamp black? I of course have reference to the hardening of the metallic soap-ceresin composition to make it suitable for the molded record art.

*A.* Asphalt when purified is a hard brittle hydrocarbon. I have never incorporated this ingredient with the metallic soap composition of the patent in suit to determine whether it is miscible with such composition or whether it would increase its hardness. Carnauba is a hard wax and will increase the hardness of the metallic soap composition. The expression "metallic soap" is a very broad term, broad enough to cover the sodium stearate and aluminium stearate in the said metallic soap composition. A further addition of sodium stearate to a composition already containing sodium stearate and an excess of stearic acid and ceresin might have a slightly increased hardening effect for the reason that, if I remember correctly, sodium stearate is slightly harder than stearic acid, although I am not positive about this. This expression "metallic soap" might cover the addition of soft soap to this composition, in which case the hardness would not be increased. Celluloid is a colloid of nitrocellulose. Whether or not it would be soluble in either stearic acid sodium stearate or ceresin, I am unable to say because I have never tried the experiment. Glue is a hard, tenacious substance when dry. I have never attempted to incorporate glue with the soap composition and am not prepared to state of my own knowledge whether it would incorporate or render the substance harder if incorporated. I have tried no experiments with resin for the purpose of determining whether an addition would increase the hardness. Stearic acid is an ingredient of the composition and possesses a certain degree of hardness of itself. A further addition of stearic acid would hardly be expected to vary this physical characteristic to any appreciable extent. Magnesium palmitate is a metallic soap. I have never tested its hardness and have never added it to the composition to determine whether it would increase or decrease the hardness of the same. I have never experimented with gum balata, gun cotton, ebonite, shellac, gutta-percha, sealing wax, vulcanite, chromatized gelatine, rosin and colodion for the purpose of determining whether their addition to a metallic soap composition would increase or decrease its physical characteristic of hardness, and I do not know. Lead stearate, magnesium stearate, aluminium stearate and stearate of soda are metallic soaps of which aluminium stearate and stearate of soda enter into the metallic soap composition of the patent in suit. Aluminium stearate does not of itself possess the desired degree of hardness. Stearate of soda, as I have previously stated, if added to the composition containing an excess of the stearic acid, might slightly increase its hardness, for it is my opinion that stearate of soda is slightly harder than stearic acid, though I have never determined that point. Even if it is harder the degree of hardness is so insignificant that it would be immaterial. I am not prepared to state whether lead stearate and magnesium stearate would or would not increase the hardness, as I have never tried it. Plaster of Paris and sand, would be undesirable ingredients to add for the purpose of hardening the soap composition of the patent in suit, but as I have never tried the experiment of incorporating plaster of Paris and sand for the purpose of determining their hardening effect, I will have to answer this upon my general knowledge of the properties of these substances themselves, and would say that they are not suitable. Chalk and slaked lime are substances which might react with the stearic acid and produce metallic soaps, but as I have never prepared a metallic soap by the reaction of chalk and slaked lime on stearic acid I cannot state on my own knowledge what effect it would have. Sawdust is an ingredient with which I have never experimented in connection with soap compositions. It is my opinion that its addition to the soap composition of this patent in suit would not promote a desirable degree of hardness. Lamp black is a coloring agent and is composed of finely divided particles of carbon. Its addition to the soap composition of the patent in suit would act as a coloring agent, and not as a hardening agent.

*xQ.* 67. With the exception of stearic acid and aluminium stearate, concerning which you appear to have some doubt, would you regard the materials mentioned in *xQ.* 66 as "hard" when compared to the metallic-soap-ceresin composition?

*A.* The following substances at normal atmospheric temperature enumerated in this list are harder than the metallic soap composition of the patent ,to wit: asphalt when in a purified state; celluloid, glue, certain resins, carnauba, ebonite, shellac, saw dust, guttapercha (pure), sealing wax, vulcanite, chromatized gelatine and rosin. Of the remaining substances some mettalic soaps might be harder and some softer. Rubber cannot be said to be a hard substance; it is rather a tough substance, and for this reason it is difficult to make a comparison of a soap composition and rubber. Magnesium palmitate, lead stearate, magnesium stearate are substances, the hardness of which I am not familiar as compared with the soap mixture of the patent in suit. Plaster of Paris, as it is ordinally understood, is a powder, consisting of calcium sulfate and may exist in a hydrated or dehydrated state. The individual particles of plaster of Paris are harder than the said soap composition. Collodion is ordinarily a liquid and its degree of hardness in a liquid condition is not comparable with a solid. Chalk or calcium carbonate may exist in a coherent mass such as found in chalk beds in which case it would be harder than the said soap mixture of the patent in suit. When in powdered form the individual particles would also be harder. Slaked lime is hydrated calcium oxide and is usually in the form of a fine powder and it is very difficult to make a comparison of the hardness with a soap composition, such as that of the patent in suit. In fact such a comparison could not be properly made. Lamp black occurs also in a very light powder, and in bulk can not be said to have any degree of hardness, and therefore cannot be properly compared in this respect with the soap mixture of the patent.

*xQ.* 68. Of the several materials referred to in *xQ.* 66, is it not a fact that with the exception of carnauba wax you are unable to say without making independent experiments that they could be used effectively in this art for the hardening of metallic soap compositions?

*A.* There are certain of these ingredients which experiment might disclose would be suitable hardening ingredients and there are others which it would not be worth while to experiment with, such, for example, as sand. However, sand, which is silica, if that should be included in the term "sand" might add a certain degree of hardness. It would hardly be worth while to experiment with sawdust, if sawdust means coarse grains of wood.

Adjourned to Tuesday, January 22, 1907, at 10:00 A. M.

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WASHINGTON, D. C., Jan. 22, 1907.

Met pursuant to adjournment.

Parties present as before.

(Mr. DYER proceeds with the cross-examination of Mr. HOLTON):

*xQ.* 69. You state in your direct testimony, *Q.* 3, that carnauba wax contains only "a minute quantity of free alcohol (myricyl alcohol)." What authority have you for this statement?

*A.* As an authority for such a statement I refer to Chemical Technology and Analysis of Oils, Fats and Waxes, Lewkowitsch, Vol. II, page 874, line 1 and 2, paragraph 1, in which it states:

> "Carnauba wax consists chiefly of myricyl cerotate and small quantities of free cerotic acid and myricyl alcohol."

I understand by this statement that myricyl alcohol is present in carnauba wax in such small quantities as to be practically negligible when carnauba wax is used as a hardening agent in the composition of the patent in suit.

*xQ.* 70. Is this the only authority on which you rely in support of your statement? *A.* It is not.

*xQ.* 71. What other authority do you rely upon in support of the statement that carnauba wax contains only a minute quantity of free alcohol?

*A.* I come also to that conclusion that there must be a minute quantity of free alcohol in the carnauba wax from various considerations. First, from a study of Mr. Aylsworth's analysis of the Columbia Composition, as given in answer to *Q.* 8 of Mr. Aylsworth's deposition. Second, from a study of and comparison of the "Defendant's Exhibit, Thornberry Record, Formulæ B with Carnauba" and my own experiments.

*xQ.* 72. I suppose you use the word "minute" in defining the amount of free alcohol in carnauba wax in the sense that the text writer, Dr. Lewkowitsch, uses the adjective "small"?

*A.* I use the term minute taking into consideration the purpose for which carnauba is used in this record composition. To my mind it signifies such a small quantity of the substance in question, myricyl alcohol, that it is practically negligible in the final result. The terms "minute" and "small" are relative terms but I understand, and mean, that whatever the quantity used here is such a small quantity as to produce no appreciable effect in the composition.

*xQ.* 73. How large a percentage of myricyl alcohol would you regard as minute or negligible?

*A.* Such a quantity, even if it is assumed to combine with the stearic acid (free) in the soap compositon of the patent in suit that the resulting compound ether would have no practical effect in the composition.

*xQ.* 74. That is to say, there might be 50% of free myricyl alcohol in carnauba wax and if it did not result in the formation of a compound ether and had a practical effect in the resulting composition, you would regard it as minute or negligible?

*A.* Carnauba wax with 50% free myricyl alcohol cannot be considered to be a minute or small proportional quantity. Such a quantity as you assume, if the reaction referred to does take place, would use up or combine with an appreciable amount of the stearic acid and such combination would manifest itself in the result of Mr. Aylsworth's analysis, or in experimental work of my own, and Mr. Aylsworth's analysis does not show any such result.

*xQ.* 75. How large a percentage of phosphorus would you consider to be negligible in steel?

> By Mr. Lewis—Question is objected to as wholly irrelevant, since the amount of phosphorous present in steel and the amount that might or might not be negligible therein, can have no bearing upon the question of how large an amount of myricyl alcohol could be regarded as negligible in carnauba wax when used for the purpose involved in this suit.

*A.* Respecting the quantity of phosphorous that may be negligible in steel is a matter with respect to which I am not posted.

*xQ.* 76. It is, however, enormously less than 1% is it not?

> By Mr. Lewis—Same objection.

*A.* It has been many years since I made any analysis of phosphorous in steel, and as steel analysis can be readily found in text books I will have to refer you to such works.

*xQ.* 77. Is not my question one which ought to be capable of a more definite answer from a scientific chemist?

*A.* Well, if you want some information on steel I can give it to you. The quantity of phosphorous in steel is a comparatively small amount with respect to the total composition of the steel, and it depends on the method of production of the steel, whether the ore is of high phosphatic value, whether in the course of manufacture it has been more or less removed, it depends upon the kind of steel, it is usually less than 1%, sometimes going into the hundredths and possibly less. The exact figures I could not give you although I have made analyses of steels, yet this was some twenty years ago.

*xQ.* 78. And, is it not a fact that in many industrial arts in which chemistry forms a part what might appear to be a small percentage of an ingredient in its effect on a given composition may be very important?

*A.* Small quantities, or even minute quantities, of substances which are in no way similar in their properties with the substance to which they are added may produce surprising effects, as, for example, the quantity of phosphorous in steel. However, one would not expect such surprising results if one kind of steel—without the phosphorous—were added to another kind of steel. The differences in properties would not be expected to be so marked.

*xQ.* 79. Are you aware of the fact that Story Maskelyne states that there is 30% of free myricyl alcohol in carnauba wax?

*A.* I am not aware of such a statement, but I am aware that up to the time of the investigations which are referred to in Dr. Lewkowitsch's book, there had not been reported any very accurate statements or work respecting the composition of carnauba wax, and I presume the authority you refer to is not the latest authority.

*xQ.* 80. Are you familiar with the investigations of Sturcke relating to carnauba wax?

*A.* As reported in Dr. Lewkowitsch's book, I am.

*xQ.* 81. Where do you find in any of Mr. Aylsworth's analyses the statement or indication that there is not free myricyl alcohol, or only a negligible quantity of free myricyl alcohol, in carnauba wax?

*A.* I arrive at this conclusion by the following demonstration: Mr. Aylsworth's analyses, as reported in answer to Q. 8, of his direct deposition shows in the Columbia composition stearic acid, 71.8%, sodium oxide, 3.8%, aluminium oxide, 0.7%. By ordinary chemical computations I have determined the quantity of stearic acid that would combine with 3.8% of sodium oxide and 0.7% of aluminium oxide, and find this quantity to be 44.2%. This deducted from the total stearic acid as stated in this analysis, which is 71.8%, would give 27.6% of uncombined stearic acid. I have also found by similar calculations that the percentage of free stearic acid in Defendant's Exhibit, Thornberry Record, Formula B With Carnauba, is 28%. I have found by direct determination the quantity of free stearic acid in "Defendant's Exhibit, Thornberry Record, Formula B With Carnauba" to be 27.8%. Now, by a comparison, assuming that the stearic acid which may have been driven off in the course of manufacture has been replaced, as stated in Mr. Aylsworth's deposition, it is found that the quantity which remains after deducting the stearic acid combined with soda and alumina from the analysis of the Columbia composition is practically identical with that which is found by calculation in Defendant's Exhibit, Thornberry Record, Formula B With Carnauba. This in itself amounts to a practical demonstration that there is no third body such as myricyl alcohol with which the stearic acid combines in any appreciable amount. If there had been another substance present in an appreciable quantity with which the stearic acid could combine, Mr. Aylsworth's analysis would have shown a smaller percentage of free acid. Further, the direct determination of the free stearic acid is 27.8%. This is practically identical with what Mr. Aylsworth's analysis shows, to wit, 27.6%, and also is practically the same as the quantity of free stearic acid in the Thornberry Record, to wit, 28%. This amounts to a practical demonstration that the quantity of myricyl alcohol with which the stearic acid is alleged to combine is very small indeed and is negligible.

*xQ*. 82. Are the calculations or computations, referred to in your last answer, what you refer to in answer to *xQ*. 74 as "experimental work of my own"?

*A*. By the expression "or in experimental work of my own" I mean my own determination of the free stearic acid in the Thornberry Record, Formula B. I do not mean to include under the term "experimental work" calculations as they are not experimental work. My determination of the free stearic acid in the composition is included in the expression "experimental work."

Adjourned for luncheon.

*xQ*. 83. In making your determination or calculations what formulæ did you use for stearic acid?

*A*. The formula which I used for stearic acid was one which corresponded to a combining weight of 270. This corresponds not to pure stearic acid but to commercial stearic acid containing a mixture of stearic acid and palmitic in the proportions of 50% of each. I find in Mr. Aylsworth's patent in suit that the stearic acid used melts at about 136 degrees Fahrenheit. This corresponds substantially to a mixture of 50% of palmitic and stearic acid. This combined weight or mean molecular weight is given on page 408, Vol. 1 of Lewkowitsch's Chemical Technology and Analysis of Oils, Fats and Waxes and corresponds to a mixture of stearic and palmitic acid in the proportions of 50% of one to 50% of the other.

*xQ.* 84. Do you find in Mr. Aylsworth's analysis any direct statement of free stearic acid, or did you determine this from calculations?

*A.* I determined it from calculation, using the combining weight of 270. for the stearic acid.

*xQ.* 85. Then, as I understand it, you compare the amount of free stearic acid alleged by you to be determinable from the analysis made by Mr. Aylsworth with the free stearic acid actually determined from Mr. Thornberry's exhibits?

*A.* I have assumed that the acid which is remaining after the deduction of stearic acid combined with the soda and alumina is the free stearic acid of the composition shown by Mr. Aylsworth's analysis, and I compare this free stearic acid with that determined by the analysis of Mr. Thornberry's Record, Formulæ B With Carnauba.

*xQ.* 86. Are you prepared to say from your own experience or from knowledge obtained from any source that under the conditions of temperature and operation set forth in the patent in suit, there may not be an interaction between the combined myricyl alcohol of the carnauba wax and the stearate of soda containing the free stearic acid?

*A.* This question is not definite and I would like to have it stated whether this question calls for a reaction between the stearic acid and the combined myricyl alcohol.

*xQ.* 87. No; what I would like to know is whether, in your opinion, there might not be a reaction between the stearate of soda and the combined myricyl alcohol?

*A.* I do not know. I am not prepared to say.

*xQ.* 88. In answer to *Q.* 4 you state that a reaction between the free myricyl alcohol and the free stearic acid "is barely within the range of possibility." Would not this be the reaction which would be naturally expected under the conditions of the patent in suit?

*A.* It is quite possible that such a reaction might take place. The affinity, however, of the higher fatty acids is very weak, and as I stated in another part of my deposition that I am not prepared to say

> "that such combination of these two bodies in the composition of the patent is beyond the realm of possibility."

*x*Q. 89. Is it not a fact that the affinities of the higher fatty acids at ordinary temperatures are very weak in comparison with the lower fatty acids, but that at the high temperatures of the patent they are stronger than the affinities of the lower fatty acids, and are even stronger than the affinities of certain mineral acids, such as hydrochloric acid?

*A.* I agree with the first statement in this question that the affinities of the higher fatty acids are weaker than the affinities of the lower fatty acids at ordinary temperatures, but I am not prepared to say—for I have never made the determination—whether the affinities of the higher fatty acids are stronger at higher temperatures than that of hydrochloric acid.

*x*Q. 90. Are you prepared to say that at the high temperatures of the patent in suit the affinities of the higher fatty acids are higher than those of the lower fatty acids?

*A.* I am not prepared to say.

*x*Q. 91. Is it your idea that the wax-like compound ether that exists in the final composition of the patent in suit is for its greater part the same wax-like compound ether that originally existed in the carnauba wax?

*A.* It is my opinion that the greater part of the wax-like compound ether that exists in the composition of the patent in suit is the same as the wax-like compound ether added in the form of carnauba wax.

*x*Q. 92. Assuming that you are correct in stating that only a minute quantity of free alcohol exists in carnauba wax, is it in your opinion possible that under the conditions of the patent in suit reactions may take place by which the myricyl cerotate will be converted into a different ether?

*A.* To determine whether or not myricyl cerotate would be changed into a different ether at the temperatures of the patent in suit would require a careful investigation of the composition, and whether or not such an investigation would be able to definitely determine such a change, I am unable to state as I never have carried on such an investigation.

*x*Q. 93. Have any scientific chemists, to your knowledge, ever attempted to determine whether or not the reactions which are set forth in the patent do in fact take place?

*A.* What may have been done in private laboratories by scientific chemists which has never been published, I am not aware and have no means of knowing. There is no literature, so far as I know, which discloses any investigation of the composition of the patent in suit for the purpose of determining the reactions which are set forth in the patent in suit.

*xQ.* 94. Is it not possible, under the conditions of temperature and operation set forth in the patent in suit, that water in being driven off may cause the release of myricyl alcohol from the myricyl cerotate, just as superheated steam causes the release of glycerol in stearic acid manufacture, and thereby presents an added body of free alcohol with which the free stearic acid may combine?

*A.* This question omits to specify at what temperature the water is supposed to be present, and this it appears to me would have some bearing on the question.

*xQ.* 95. I have reference to the temperature mentioned in the patent in suit, namely, about 450° F., at which temperature water may be driven off by reason of chemical reactions within the heated mass?

*A.* I am unable to say whether water present at this temperature would cause a liberation of myricyl alcohol as in the case of glycerine manufacture. Yet it is my opinion that if such reaction did take place it would not be very extensive because of the small quantity of water that would probably be present as a result of chemical reaction, and I have never carried on the experiments to determine this particular question.

*xQ.* 96. Is it not a fact that in many of the industrial arts, in which chemistry forms a part, the reactions which are supposed to take place are largely theoretical as to which scientific chemists do not agree? Specifically, is it not a fact that at the present time more than thirty years after the invention of the storage battery by Plante, skilled electrochemists of the highest technical knowledge do not agree as to the reactions which take place in the storage battery? And, at the present time, more than fifty years after the invention of photography there are many theories explanatory of the phenomena that have their enthusiastic adherents among truly scientific chemists?

By Mr. Lewis—Objected to as grossly irrelevant and immaterial to any issue involved in this case.

By Mr. Dyer—The question is believed to be perfectly material as showing the unreliability and uncertainty that can be placed on any statements of positive chemical reactions.

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*A.* With respect to each one of the statements in this question, there are many things in the way of chemical reactions concerning which scientific chemists do agree. There are other things involving chemical reactions in the arts, for example, storage battery and photography, referred to, concerning which chemists do not agree. Yet as investigations in these arts proceed differences with respect to the theory of these chemical reactions are reduced.

*xQ.* 97. The patent in suit describes carnauba wax as "consisting of a mixture or combination of the higher fatty acids and alcohols." Is not that a fairly accurate defintion?

*A.* This definition of carnauba wax is not an accurate definition for it states "the latter consisting of a mixture." This mixture may mean a mixture in the sense of mechanical mixture, of the higher fatty acids and alcohol. On the latest authorities the composition of carnauba wax consists chiefly of the combination of a particular higher fatty acid, to wit, cerotic acid and an alcohol—myricyl alcohol. To be sure, there are small quantities of free acid and free myricyl alcohol. The definition has not been prepared, in my opinion, with extreme care.

*xQ.* 98. On the contrary, does not the book which you take as your authority, Lewkowitsch, state that carnauba wax contains two separate higher fatty acids and three alcohols, and if some of the alcohols exist in the free state then is not carnauba wax both a mixture and a combination?

*A.* It is literally true that there are small quantities of free fatty acids and free alcohols in carnauba wax, and Mr. Aylsworth has testified that these bodies, as I now remember, are present to the extent of about 5%. The literal accuracy of this definition, as I above stated, may not be disputed yet it is not a definition which has been prepared with extreme care. The definition given by Mr. Aylsworth in his deposition, *Q.* 4, is more accurate and satisfactory, to wit:

> "It is composed chiefly of myricyl alcohol combined with cerotic acid and myricyl alcohol in the free state and small percentages of other alcohols and acids in which the percentage does not exceed 5% in the average lots of carnauba wax."

*xQ.* 99. But your objection to the definition of the patent is not that it is inaccurate but that it is not as complete as it might have been?

*A.* The term "accurate" is defined in The Century Dictionary as "characterized by extreme care." In this sense in my opinion the definition is not accurate, though it is a literally true statement.

*xQ.* 100. In answer to *Q.* 4 you state that "the patentee had a metallic soap which he *thought* was not hard enough for his purpose." Upon what do you base this statement?

*A.* The patentee describes in the patent in suit the preparation of a metallic soap. It is well known that prior to this patent carnauba wax had the properties of a hardening agent and has been used for hardening various compositions, such as that of a graphophone tablet. In fact, the purpose of carnauba wax for use in the manufacture of tallow candles, polishing pastes and phonograph cylinders is indicated by the fact that the mention of its use in these compositions has been incorporated in the latest work on Chemical Technology, such as Lewkowitsch, Vol. 2, page 874, lines 19, 20 and 21. In view of the fact that the patentee had in the art as illustrated in the Tainter patent No. 421,450, of record herein, a hardening agent such as carnauba wax, it is reasonable to assume that if he wanted to harden a metallic soap he could select such an old hardening agent, such as carnauba wax.

*xQ.* 101. What is the date of the book of Lewkowitsch to which you refer? *A.* 1904.

*xQ.* 102. My *xQ.* 100 was directed more to ascertain the basis of your statement as to what the patentee "thought" or had in mind. Having before him a metallic soap, would it not be just as reasonable to say that he thought it did not have the proper requirements as to shrinkage and warping and added carnauba wax in a peculiar way to remedy those defects?

*A.* Mr. Aylsworth states in his patent in suit "it should be very hard when set so as to reduce wear as much as possible due to the tracking of the reproducer." This statement clearly indicates that the composition without carnauba wax is not hard enough. He must therefore have had in mind to add something to harden it, and he directs, page 2, lines 77 to 80 of the patent in suit:

> "I now add to the molten metallic soap mixture 21.36 pounds of very hard wax, preferably carnauba."

In reply to the last statement in your question, it is my understanding that the soap composition before the addition of carnauba has the requisite degree of shrinking. I therefore do not see why carnauba wax should be added for the purpose of increasing the shrinkage. As I am not an expert on the molding of these records I do not know whether the soap mixture warps or not without the carnauba.

*x*Q. 103. Then your explanation of the inventor's mental attitude was not founded on any knowledge in the art but was based purely on speculation founded upon your particular view of this case, namely, that the sole contribution of the patentee was the addition of a hardening ingredient to an otherwise eminently successful material for use in this specific art, and under the conditions which have been practically developed therein?

*A*. My explanation is based on what appears to me to be an obvious use of carnauba wax, it being well known that it has the capability of imparting hardness to compositions such as that of a record composition.

*x*Q. 104. But you do not claim to have any direct knowledge or information of what the patentee's mental attitude may have been in developing the composition of the patent in suit?

*A*. I have no knowledge of the mental attitude of the inventor other than what would appear to be a reasonable thing to do under the conditions, to wit, that here is a record composition which it is desirable should be capable of having a greater hardness. It is reasonable to my mind that the addition of a hard wax, like carnauba wax, would obtain the desired result.

*x*Q. 105. And your position is based, necessarily, upon the presumption that the material which the patentee sought to harden was otherwise entirely suitable for the purpose?

*A*. As I previously stated, I do not claim to be an expert on molding record compositions. It appears to me, however, without such exact knowledge that the metallic soap composition was otherwise suitable for the purpose.

*x*Q. 106. Is not your entire deposition based on the assumption that the metallic soap composition, except for the quality of hardness imparted to it by the carnauba wax, *is* entirely suitable for use in this art?

*A*. It is based on the ground that the purpose of the addition of carnauba wax is to harden the composition. What other functions it might have are insignificant compared to this object.

Adjourned to Wednesday, January 23, 1907, at 10:00 A. M.

WASHINGTON, D. C., Jan. 23, 1907.

Met pursuant to adjournment.

Parties present as before.

(Mr. DYER proceeds with the cross-examination of Mr. HOLTON):

*xQ*. 107. In answer to *Q*. 3 you refer to chemically charring. Does not such an operation presuppose some chemical reaction?

*A*. It presupposes that the substance charred has undergone some kind of chemical reaction, such as the charring of fibrous materials where the structure of the fibre would be broken down.

*xQ*. 108. Regarding the claims which you refer to in this same answer, you recognize the fact, do you not, that claim 1 and other claims that refer to "a hard wax" might cover a composition in which a suitable wax was used that did not contain a compound ether and from which a compound ether would not result, while the seventh claim and other claims which refer to a wax-like compound ether are restricted to a composition in which such a compound ether is formed or is present?

> By Mr. Lewis—Question objected to as improper insofar as it asks the witness to determine the scope of the claims, particularly as counsel does not specifically designate the ingredients of his assumed composition.

*A*. By the term "a hard wax," as used in this patent, I understand that it refers to "a very hard wax, preferably carnauba, the latter consisting of a mixture or combination of the higher fatty acids and alcohols." (Page 2, lines 79-82 of patent in suit.) I further find it stated in this patent that bees wax, Chinese wax and palm wax may be substituted for the carnauba wax: see lines 31-39, page 3 of patent in suit, where it states:

> "While I prefer in all cases to make use of carnauba-wax, as described, yet I find that bees wax and Chinese wax and palm wax all contain alcohols somewhat similar to those of carnauba wax and by which substantially similar reactions take place. These materials may therefore be substituted for the carnauba wax, but always at a sacrifice in the desirable condition of the resulting products."

The patent gives as an illustration of the waxes suitable for the purpose of the invention each of which contains a compound ether and the one preferably used, to wit, carnauba wax contains free alcohol. I therefore conclude that the hard wax, referred to in these claims, is such a wax as has been given in the illustration and that it must contain a compound ether. I also observe the statement in this patent, page 2, lines 113-118, to wit:

> "After the treatment of the molten material at a high temperature has been effected and all foaming has ceased I add twenty-one and thirty-six hundredths pounds of ceresin thereto, although other hydrocarbon waxes may be employed, such as paraffin or ozocerite."

Reference is here made to waxes. These waxes, however, are what are termed hydrocarbon waxes and do not contain the compound ethers found in the hard wax which is directed to be added to the metallic soap mixture. I therefore conclude that these are not the waxes that are referred to in the claims, where the expression "hard wax" alone is used.

*xQ*. 109. In answer to *Q*. 9 you state that there is no chemical authority "for saying that a wax-like compound ether will be produced by any reaction occurring between the materials of the composition of the patent in suit if there is no *free* alcohol in the 'hard wax' that is added to the mixture." I suppose you will admit that there is no authority that denies the possibility of such a reaction?

*A*. I know of no chemical authority that either affirms or denies that a wax-like compound ether will be produced by any reaction occurring between materials of the composition of the patent in suit if there is no *free* alcohol in the "hard wax" that is added to the mixture.

*xQ*. 110. Nor, as I understand it, is there any chemical authority that denies the possibility of other reactions occuring in the composition under the conditions of temperature and of operation set forth in the patent in suit?

*A*. By the term "other reactions" I understand your question to include the reaction of free stearic acid on the free myricyl alcohol in the carnauba wax when that is used. With respect to this particular reaction I have found that it does not occur under the conditions stated in the patent in suit to any such extent as to be appreciable or to have any effect on the composition. The action of a free acid upon a free alcohol, if it reacts at all, is not an instantaneous reaction, but one which requires time, and when it does take place it is a progressive reaction up to a certain extent. If any reaction takes place in the composition between the free acid and the free myricyl alcohol, it has not progressed far enough or to such an appreciable extent as to be detected by analysis of the composition.

*xQ*. 111. I think you have misapprehended my question in two respects. I would like to know, first, aside from your own observations or theories, whether there is any authority—by which I mean the writings or observations of scientific chemists who can speak with certainty—and, second, whether such authority or authorities deny the possibility of *any* chemical reactions taking place under the conditions of the patent, when the carnauba wax is added to the metallic soap mixture at the temperature and under the conditions set forth therein?

*A.* I know of no such authorities as you refer to.

*xQ.* 112. In answer to *Q.* 11 you criticized Mr. Aylsworth's formulæ of stearate of soda as lacking five molecules of hydrogen, as given in his answer to *xQ.* 75. In this same answer of Mr. Alysworth, is not the proper amount of hydrogen given in connection with the formulæ for stearate of alumina and would you not conclude therefrom that the error in the formulæ for stearate of soda was purely typographical?

*A.* The radical for stearic acid is correct when applied in the formulæ of alumina stearate, and I conclude that the radical in the formulæ for sodium stearate was a typographical error.

*xQ.* 113. You do not contend, do you, that the material described in Tainter patent No. 421,450, possesses the quality of hardness and the other qualities necessary in this molded record are?

*A.* With respect to the feature of hardness I understand that the composition of the Tainter patent to be of the "right degree of hardness and toughness without being brittle" without being too hard for cutting or being graven by the cutting style. If this composition were to be used for a molded record it would, in my opinion, be desirable that the composition should be harder. With respect to other qualities referred to in the question, I am uncertain as to just what that means. I would like the question stated more specifically in this respect.

*xQ.* 114. I will state the question in this way. In your opinion, does the Tainter patent No. 421,450, disclose a material or composition suitable for use in the molded record art?

*A.* This composition is capable of being molded, but of my own experience I am unable to say whether it would meet all the requirements of a composition for use in the molded record art. I have conducted no experimental work in this direction.

*xQ.* 115. Ozocerite is crude ceresin, is it not?

*A.* Ozocerite is a substance from which ceresin is derived by a process of purification.

*xQ.* 116. By the treatment of ozocerite, described in the Tainter patent, is not the toughening due to the evaporation of more or less volatile impurities therein?

*A*. By the boiling of the ozocerite volatile materials are no doubt driven off and their elimination contributes to the toughening effect.

*xQ*. 117. If ceresin or purified ozocerite is subjected to the treatment of the Tainter patent, would it become harder or tougher?

*A*. I have never conducted any experiments to determine this, and I am unable to give a positive answer.

Adjourned for luncheon.

*xQ*. 118. Your answer to *Q*. 14 is not absolutely definite. Is it my understanding that you consider the formation of the compound ether, when stearic acid is mixed with beeswax at their melting points, to be only remotely possible?

*A*. It is my understanding that such a reaction is remotely possible and not only that but very remote.

*xQ*. 119. As to the statement made in the patent in suit, as well as by Mr. Aylsworth in his deposition, that when carnauba wax is added to the metallic soap composition at a high temperature, chemical reaction, whatever they may be, take place, which do not take place when the carnauba wax is added at a lower temperature, is it your position that this is not correct or do you merely question the sufficiency of the evidence mentioned by Mr. Aylsworth in support of his statement, and particularly the fact mentioned by him that the addition of carnauba wax at a high temperature is accompanied by frothing and foaming?

*A*. Mr. Aylsworth states in his deposition, in reply to *Q*. 5, as to what chemical combination if any will be effective that

> "The free myricyl alcohol of the carnauba wax will combine with the free stearic acid to form a compound, known as an ether, or compound ether."

I question the sufficiency of the evidence furnished by Mr. Aylsworth to establish the formation of such a compound ether by the reaction of myricyl alcohol of the carnauba wax with free stearic acid. I have demonstrated to the satisfaction of my own mind that such reaction, if it takes place at all, is to such a slight extent that it is practically negligible. The evidence of frothing and foaming are given by Mr. Aylsworth for the purpose of establishing a reaction between the stearic acid and the alcohol of carnauba wax. Whatever other reactions may take place under the condition of carrying out the preparation of the composition of the patent in suit they have not been indicated. It is my opinion that Mr. Aylsworth is in error in assuming that there is a reaction between the myricyl alcohol and the stearic acid to any appreciable extent, and that his evidence for establishing this alleged reaction is insufficient, and could not be accepted by a scientific chemist as proof of the formation of a wax-like compound ether, as stated in lines 98 and 99, page 2 of the patent in suit.

*xQ.* 120. I think you have misapprehended my question, and I will therefore try to make my position clear. The patent in suit states that when carnauba wax is added to the metallic soap at a high temperature and the heating is sufficiently prolonged, the resutling composition possesses different physical characteristics than when the carnauba wax is added at a lower temperature. The patent attempts to explain this difference in physical characteristics on the assumption that a reaction takes place at the high temperature between the free stearic acid and the free alcohol of the carnauba wax, resulting in the formation of a compound ether. I understand that you do not agree with this explanation of the patent, and I don't suppose that you would alter your opinion in this respect. Whether the patent is right or whether you are right will, I take it, be determined by the weight of evidence. In order, however, that we might get along more rapidly I did not limit my question to a particular reaction but referred to any reaction whatever. Will you not tell me which, if any, of the following statements correctly embodies your views:

(a) Do you assert that when carnauba wax is added to the metallic soap mixture the composition is precisely the same whether the temperature is high, i. e., 450 degrees F. or low?

(b) Do you admit or deny that when carnauba wax is added to the metallic soap composition at the temperature and under the conditions of the patent, any chemical reaction or reactions whatever take place, due to the presence of the carnauba wax?

(c) When the carnauba wax is added to the metallic soap composition at the high temperature of the patent, is it a perfectly inert ingredient, like the ceresin, for example?

(d) When the carnauba wax is added to the metallic soap mixture, under the high temperatures and conditions of the patent, does it undergo any change or does it still remain carnauba wax?

*A.* Replying to question (a) I have never determined whether the composition referred to is precisely the same at these two temperatures, for the purpose of making a molded record, and I therefore cannot give a more definite answer to the question.

(b) In subjecting a complex, such as that of the composition of the patent in suit, to a temperature and under the conditions of the patent, the temperatures of the composition throughout the mass are not necessarily limited, as I undestand it, to 450 degrees F., as the bottom of the caldron or other vessel is subjected to a much higher temperature. I am not prepeared to say, therefore, that no chemical reaction whatever would take place under such conditions, nor do I care to assert with any greater degree of positiveness than I have in other places in this deposition, that there would be no chemical reaction whatever due to the presence of the carnauba wax. Whatever reaction might take place, due to the presence of the carnauba wax, would in my opinion be very trivial.

(c) My answer to this question is similar to that of (b). Whatever chemical reaction may take place is in my opinion practically negligible.

(d) Carnauba wax is a mixture of several chemical compounds, and when it is added to the soap composition, these several ingredients of the carnauba wax would be disseminated through the composition. It is my opinion that these several ingredients of the wax would remain there as such without undergoing any appreciable chemical change. With respect to one of these ingredients, such as the myricyl alcohol, I am convinced that it does not undergo a chemical change. With respect to the other constituents of the wax, I have no positive information. If this question means—can the carnauba wax be removed as such from the composition, and therefore remain in the composition as an entirety, it is my opinion that it does not remain in the composition as carnauba wax, as it has been dissolved, so to speak, in the composition.

*xQ.* 121. From the latter part of your answer, would not the Court conclude that your position was this—that when carnauba wax is added to the metallic soap mixture under the conditions and temperature of the patent, you are unable to state of your own knowledge whether any reactions would or would not take place, due to the presence of the carnauba, but that you incline to the opinion that reactions do not take place. Is that a correct statement of your belief?

> By Mr. Lewis—Question objected to as improper in asking the witness to define the possible conclusion that may be reached by the Court; if counsel wishes further explanation of the meaning of any part of the testimony of the witness, it is submitted that the question should properly be put in that form.
>
> By Mr. Dyer—The question is believed to be en-

> tirely proper and is designed only for the purpose of epitomizing the position of the witness.

*A.* I am not prepared to state what the conclusions of the Court may be, yet my position is this: I have demonstrated to my own satisfaction that one of the constituents of carnauba wax, to wit, myricyl alcohol, does not combine to any appreciable extent, if at all, with the free stearic acid in the metallic soap composition. From this fact, I am of the further opinion that another ingredient, to wit, the wax-like compound ether, myricyl cerotate, remains in the composition undecomposed, although I have not determined this to be a fact. I am inclined to the opinion, and from my present knowledge of the composition of the patent in suit, gained from a study of literature on the general subjects of waxes, oils and fats, and from my own laboratory determinations, that no reactions of a chemical character of any material extent take place between the free stearic acid and the alcohols of the carnauba wax. The subject, however, involves many difficulties and I am not prepared to state with a greater degree of certainty what reactions may or may not take place.

*xQ.* 122. You certainly do not want the Court to reach a conclusion from your evidence that would not accord with your own opinion, do you?

> By Mr. Lewis—This line of cross-examination is objected to as manifestly improper and irrelevant. It is not the function of this witness to state what conclusions the Court may or may not reach, or what conclusions he may hope the Court will reach, but to testify as to the facts in so far as that is within his power.
>
> By Mr. Dyer—Complainant's counsel agrees absolutely with the statement of the functions of the witness, but opposing counsel has misinterpreted the word "conclusion." The Court and complainant's counsel are certainly entitled to know what the witness is talking about; and they are entitled to a precise and definite statement of his position on any point of the case, and that is just what complainant's counsel is seeking to reach.
>
> By Mr. Lewis—The foregoing remarks by complainant's counsel disclose the fact that the question is further objectionable as being indefinite and ambiguous. If counsel wishes to know the witness' understanding of certain points, which understanding is not clearly conveyed by the testimony already given, defen-

dant's counsel as well as the witness are only too eager to accommodate complainant's counsel on this point.

*A.* It is my belief that my opinions have been definitely expressed and can be understood, as I intend them to be understood.

*xQ.* 123. This being so, please point out in what respects the statement contained in *xQ.* 121 is incorrect?

*A.* *xQ.* 121 contains this statement, to-wit:

> "You are unable to state of your own knowledge whether any reactions would or would not take place, due to the presence of the carnauba wax."

This statement is incorrect, for the reason that I have previously stated in answer to *xQ.* 120, sub (d):

> "I am convinced that it does not undergo a chemical change."

By the word "it" reference is here made to myricyl alcohol in the previous line. My reasons for this conviction that myricyl alcohol does not change or enter into chemical combination have been stated in answer to *xQ.* 81, and which I will again state. My reasons for coming to the conclusion that the free stearic acid of the metallic soap composition of the patent in suit does not react with the free alcohol of the carnauba wax are, briefly stated, as follows:

I determined by my calculations that "Defendant's Exhibit, Thornberry Record, Formulæ B With Carnauba" contains 28% of stearic acid that is not combined with the oxide, to-wit, sodium oxide and aluminium oxide. This quantity of stearic acid, to-wit, 28% is either all free or partly combined with some other body in the composition. I determined by a chemical analysis of Defendant's Exhibit Thornberry Record Formulæ B With Carnauba the quantity or per cent. of free stearic acid in the composition. If it be assumed that the 28% of stearic acid as determined by calculation exists in the said composition as free stearic acid no part of which is combined with any constituent, such as alcohol, of the carnauba wax, then this quantity must equal the quantity found in the same composition, as determined by chemical analysis. This quantity I do find to be 27.8%, which is practically identical with the quantity in the composition found by calculation. There is no other conclusion to be reached than that there has been no combination between the stearic acid and the alcohol.

Adjourned to Thursday, January 24, 1907, at 10:00 A. M.

Raymond R. Wile Research Library

WASHINGTON, D. C., Jan. 24, 1907.

Met pursuant to adjournment.

Parties present as before.

(Mr. HOLTON continues his answer to *xQ.* 123):

My second reason for coming to this conclusion, briefly stated, is as follows:

Mr. Aylsworth's analysis shows that the Columbia Composition is made up with 71.8% stearic acid. By a simple chemical calculation I find that there are 27.6% of stearic acid that is uncombined with sodium oxide, $Na_2O$, and aluminium oxide. By my own analysis of Defendant's Exhibit, Thornberry Record Formulæ B With Carnauba I find that 27.8% of *free* stearic acid is present in the said composition. This quantity is identical practically with the 28% found by calculation in the same composition, but this quantity, 28%, I have demonstrated is *free* stearic acid. I can come to no other conclusion than that the 27.6% of stearic acid uncombined with the oxides in Mr. Aylsworth's analysis is also *free* stearic acid and no part of it is combined with any other constituent such as myricyl alcohol in carnauba wax. I have made further a determination of the stearic acid in Defendant's Exhibit, Thornberry Record, Formulæ B, without carnauba wax, and have determined the quantity of stearic acid uncombined with the oxide in the quantities of this formulæ, and have compared this quantity with the quantity of stearic acid in Defendant's Exhibit, Thornberry Record, Formulæ B with carnauba, and find that these quantities are practically identical, which further proves to my mind that there is no combination of the free stearic acid and the free alcohol of the wax, or if there be any combination at all it is in such a minute and extremely small quantity that it does not affect the result.

*xQ.* 124. I have not the slightest intention of combatting what appears to be a deep-seated conviction on your part that the suggested reaction of the patent does not take place, at least to an appreciable or material extent. To my mind it is not very important whether the patent correctly explains the phenomena or the reason why the composition prepared at the high temperature is superior to the composition prepared at a low temperature. I want, however, to obtain a brief and readily comprehensible statement of your position on the point we have just been discussing. Is not this, then, a correct statement of your view: That when carnauba wax is added to the metallic soap composition at the high temperature and under the conditions of the patent in suit, you are convinced that no appreciable or material reaction takes place between the free stearic acid and the free myricyl or other alcohols in the carnauba, that whether any other reactions take place you are not able to state, but as to any other reactions you regard them as improbable. Is that correct?

*A.* I believe that I have already clearly, concisely and exactly expressed my views, but I will re-state them. It is my conviction, based upon chemical analysis as heretofore set forth in my deposition that there is no chemical combination of the free stearic acid with the free alcohol or alcohols in the carnauba wax. I am also of the opinion, in view of what I have determined with respect to the reaction of free stearic acid and the free alcohol that other chemical reactions, although they may possibly take place, are not very extensive. I have, however, not investigated other reactions than those between the stearic acid and the free alcohol, and I do not care to state what further investigations may develope with respect to other reactions.

*xQ.* 125. I did not ask you to re-state your position but I asked whether or not the statement in *xQ.* 124 was correct. Can you not answer that question categorically?

*A.* I cannot answer this question categorically, for the reason of the words in your question "you regard them as improbable." I am not prepared to say that other reactions are improbable. They might be even probable and a scientific investigation of the question show that they do not take place. They might be deemed as improbable and such investigations might show that they do take place. Under such conditions I cannot answer the question by a simple "Yes" or "No."

*xQ.* 126. Well, then, I will put the question in this form:

You are of the opinion that when carnauba wax is added to the metallic soap composition at the high temperature and under the conditions of the patent in suit, you are convinced that no appreciable or material reaction takes place between the free stearic acid and the free myricyl or other alcohols in the carnauba, but that whether any other reactions take place you are not able to state. Is that correct? *A.* Yes.

*xQ.* 127. Assuming that you had the metallic soap composition of the patent in suit before the carnauba was introduced and that you heated it at a temperature of 450° until all foaming ceased and the molten material was perfectly quiescent, and that in a separate vessel you subjected carnauba wax, previously washed and purified, to a temperature of 450° F. until all foaming or ebullition of gas ceased and the molten wax was perfectly quiescent, and that you then introduced the quiescent molten wax into the quiescent molten metallic soap, maintaining the temperature at 450° F., and you observed that when the two were added frothing and foaming resulted which persisted for several hours before the combined mixture became quiescent, would that indicate to your mind that chemical reactions were, or some chemical reaction was, taking place?

*A.* I am of the opinion that under the conditions assumed such ebullition of gas where all moisture and occluded gases have been eliminated from both compositions, and where there is no possibility of the frothing or foaming or ebullition of gas arising from temperatures higher than 450° F., or other causes than the mere mixture of these two substances at the temperature of 450°, such ebullition of gas would lead me to investigate to determine whether or not some kind of chemical reaction was taking place. Such ebullition of gas under those conditions is very suggestive of some chemical reaction taking place, either by the elimination of some gas from the individual molecules without reaction between the molecules of other substances, or there might be reactions between the molecules of different substances with the production of a gas. The mere ebullition of a gas when two substances are brought together is not necessarily evidence of a chemical reaction, unless all other causes for this evolution of gas are removed.

*xQ.* 128. Do you question the fact, as a scientific chemist, that when two perfectly quiescent, molten liquids are added together and frothing or foaming results therefrom, and all other causes of the elimination or gas are eliminated, that a chemical reaction or change is taking place?

*A.* The expression in your question "two quiescent, molten liquids" is broad enough to cover all possible molten liquids whether they be molten compounds or whether they be molten elements, and it might be possible to find two molten substances which, when brought together, might result in the ebullition of one or more of the ingredients in the form of vapor without there being a chemical reaction, all other causes being eliminated.

*xQ.* 129. How would it be chemically possible, under your assumption, for one of the elements or ingredients to be eliminated unless a chemical change did take place, assuming all other causes for the elimination of gas to be disregarded?

*A.* To illustrate my position, take two perfectly quiescent molten liquids such, for example, as molten iron and liquid or molten mercury and pour the molten iron into the molten mercury, there will be an ebullition of the vapors of the mercury.

Your question states "Do you question the fact as a scientific chemist that whenever two perfectly quiescent, molten liquids are added together and frothing or foaming results therefrom, and all other causes for the elimination of gas are eliminated, that a chemical reaction or change is taking place." This question is not limited to any kind of substance or to any temperature. In fact it might be possible to find other illustrations in the literature of chemistry.

*xQ.* 130. At what temperature is iron molten or liquid?

*A.* It is molten or liquid at a very high temperature. The exact temperature I could give you by referring to works on chemistry.

*xQ.* 131. It is over 2000° F., is it not?

*A.* It is in that neighborhood, I think. The exact figures I cannot state.

*xQ.* 132. At what temperature is mercury molten?

*A.* It is molten at ordinary temperatures.

*xQ.* 133. It is molten at least at a temperature of 30° below zero, is it not?

*A.* I think it is molten at even a lower temperature than that.

*xQ.* 134. Now, suppose we take a metallic soap composition and heat it in an open vessel at a temperature of 450° F., and we observe that during the several reactions of the stearic acid on the soda and alumina, frothing or foaming results, which persists for a number of hours but gradually dies away, becoming less and less until finally the liquid becomes entirely quiescent. At the same time we take the ordinary carnauba wax of commerce and heat the same in another open vessel at a temperature of 450° F., and we observe that there is at first more or less ebullition of gas which finally ceases and the liquid becomes perfectly tranquil and quiet. At all times we maintain the temperature of 450° F., and we then add the perfectly quiescent, molten carnauba wax to the perfectly quiescent, molten metallic soap, still maintaining the temperature of 450° F. If you observe that when the two molten liquids you have thus added together was followed by a very violent frothing or foaming which persisted for from one to five hours while the temperature was still maintained at 450° F., and then gradually was reduced until the compound was perfectly quiet, what cause other than that some chemical reaction or change was taking place can you give to explain the phenomena?

*A.* By heating in an open vessel, do I understand you to mean over an open fire?

*xQ*. 135. I mean in such a vessel as is used in this art consisting of a large tank heated either by superheated steam or by a gas or other flame beneath it.

*A*. Assuming, then, that the heating means does not produce such a high temperature as to decompose the materials adjacent those portions of the vessel in contact with the fire or heat, it is my opinion that such ebullition of gas indicates some kind of a chemical reaction taking place under the conditions which you have stated. However, I should want to assure myself that none of these gases that were coming off were not some of the vaporized products.

*xQ*. 136. Why should there be any greater tendency to decompose the materials when the two molten liquids were added together than when they were heated separately at the same temperature? Is not this hypothesis one that need not be considered in reference to the possibility of chemical reaction taking place in the assumed case?

*A*. I had in mind the possibility that in a case of heating by steam when the temperature can be very accurately regulated, that if one substance was heated by this means and the other was heated over an open fire where the temperature could not be so carefully regulated, that there might be a volatilization or decomposition of some of the products which were heated by steam alone.

*xQ*. 137. What kind of carnauba wax did you use in the experiment referred to in the answer to *Q*. 17?

*A*. The sample of carnauba wax which I have in my laboratory is one that has been there for some time and was purchased on the open market. It has a melting point, as determined by me, of nearly 84° centigrade. For the exact figures I would have to refer to my memoranda. It is between 83-½ and 84. It is very hard, can be readily ground to powder in a mortar, it has a yellowish, greenish cast or hue.

*xQ*. 138. You do not know of your own knowledge that if commercial carnauba wax is properly purified by washing, boiling off the water, and filtering, it does not froth or foam when heated up to a temperature of 450° F., but remains perfectly quiescent?

*A*. By boiling off the water I understand that it means removing all occluded water.

*xQ*. 139. Yes.

*A*. I do not know of my own knowledge that wax purified in that way, with the elimination of all moisture, mechanically occluded, and the elimination of other occluded gases which it is well known carnauba wax in its commercial condition contains, will not froth or foam when heated up to a temperature of 450° F. But I do know that carnauba wax as it comes in the market does froth and foam when heated to 450° F. And that carnauba wax persistently retains moisture when it is once incorporated therein, as by purification over water. I would hardly expect, however, that any frothing would occur if the air and moisture were all removed from the wax before heating it to this temperature.

*xQ.* 140. Would you accept as indication of reaction between the constituents of carnauba wax and the stearic acid of the metallic soap composition, the detection and separation of esters containing stearic acid or acids of lower melting point than any which exist in the carnauba wax?

*A.* By the term "esters containing stearic acid," as used in this question, I understand that all reference to such compounds as the metallic soaps of stearic acid are excluded, and that reference is made to the compounds of stearic acid and any of the alkyl or alcoholic radicals of the carnauba wax. Is that correct?

*xQ.* 141. That is correct.

*A.* The detection and separation of esters containing stearic acid and alcoholic or alkyl radicals of the carnauba wax I would accept as an indication of reaction between the constituents of carnauba wax and stearic acid. The resulting product of such a reaction, however, would in my opinion in view of the very small quantity of free alcohol or alcohols in the carnauba wax be insignificant in comparison with the esters already present in the carnauba wax. The question includes the detection and separation of acids of lower melting point than any which exist in the carnauba wax. It is quite conceivable, to my mind, that lower fatty acids might result from the decomposition of higher fatty acids in the carnauba wax, and the detection of these lower acids would not indicate a reaction between the constituents of the carnauba wax and the stearic acid.

*xQ.* 142. Assume that a reaction does take place between the stearic acid and the free myricyl alcohol, what will the reaction yield?

*A.* If such a reaction should take place between the free stearic acid and the free myricyl alcohol the reaction would be expected to result in the formation of an ester containing the alkyl radical of the myricyl alcohol in combination with the acid radical of stearic acid, and the elimination of a molecule of water. The question, as I understand it, presumes that this reaction takes place at the temperature or temperatures specified in the patent in suit, under which conditions this water would probably be eliminated if it did not enter into any other reaction. However, as I have previously stated, whatever such reaction might take place would be very limited for the reason that the quantity of free myricyl alcohol or alcohols in the carnauba wax is very small.

*xQ.* 143. Can you give me the chemical equation of the reaction?

*A.* I take it that this question calls for the reaction between stearic acid having the formula $C_{18}H_{36}O_2$ and myricyl alcohol having the formulæ $C_{30}H_{62}O$, which is the formulæ given in the latest text-books. The reaction would be $C_{30}H_{61}OH+HC_{18}H_{35}O_2=C_{30}H_{61}C_{18}H_{35}O_2+H_{20}$.

*xQ.* 144. Is it not a fact that hydrocarbon compounds of high molecular weight tend to split or decompose into oily products and hydrocarbons of lower molecular weight when highly heated?

*A.* The expression "highly heated" occurring in this question is very indefinite and vague. When hydrocarbon compounds are highly heated as in the destructive distillation of such compounds for the production of gas, such hydrocarbon compounds are cracked and decomposed into oily products and gaseous products and hydrocarbon compounds and hydrocarbons of lower molecular weight. Stearic acid, for example, is stated on the latest authority, Lewkowitsch, for instance, Vol. 1, page 94, requires a temperature of at least 680° F. for boiling, at which temperature decomposition ensues more or less. This temperature of 680° F., which probably is the minimum, is considerably removed from the temperature of 45° F. used in the patent in suit. It is quite possible that when the composition is heated over an open fire in a caldron of metal, that temperatures as high as this are reached in the lower layers of the mixture next the fire.

*xQ.* 145. I had reference to no specific hydrocarbon compounds, but my question was directed more to the end of ascertaining the general rule as to their behavior under high temperatures which would, of course, depend upon the individual compounds, some requiring a higher temperature to split them than others. My question, however, *xQ.* 144 was generally correct, was it not? *A.* Yes.

*xQ.* 146. And is it not also a fact that paraffins of high melting point and high molecular weight are harder than paraffins of low melting point and low molecular weight?

*A.* If this means chemically pure paraffins of the paraffin series, yes, in a general way.

*xQ.* 147. If you were given a sample of the composition of the patent in suit made as specified therein, could you determine the amount of stearic acid which exists in the composition in combination with myricyl or other alcohol, assuming that such a combination is present. In referring to stearic acid I, of course, have reference to commercial stearic acid which, I understand, to be composed of about half palmitic acid.

*A.* Whether I could make such a determination or not I could only answer by making the trial.

RE-DIRECT EXAMINATION, By Mr. LEWIS:

*R-dQ.* 148. Professor, referring to Macdonald patent No. 606,725, Formula B, if you have made any calculations to determine the amount expressed in pounds of free stearic acid (that is, stearic acid which would not be neutralized by the sodium and aluminium oxides employed), please state the amount of free stearic acid in pounds? *A.* 122.4 pounds.

*R-dQ.* 149. That is, there would be 122.4 pounds of free stearic acid in the composition resulting from the employment of Formula B of the Macdonald patent No. 606,725? *A.* Yes.

*R-dQ.* 150. Now Professor, referring to the Thornberry record, Formula B with Carnauba, and assuming the amounts of materials employed to be the amounts given in Formula B of the Macdonald patent No. 606,725, plus 64 pounds of carnauba, if you have made any calculations to determine the amount of stearic acid in that composition which would not be neutralized by the sodium and aluminium oxides employed, please state the amount in pounds? *A.* 122.4 pounds.

*R-dQ.* 151. The Thornberry record, Formula B with Carnauba (meaning the one referred to in my last question) is made from a composition obtained by the employment of Formula B of Macdonald patent No. 606,725, plus the proportinate amount of carnauba mentioned in the Aylsworth patent as being added to the metallic soap composition, I understand?

*A.* I so understand.

*R-dQ.* 152. If you have made any analysis of the Thornberry Record, Formula B with Carnauba to determine the amount of free stearic acid in the composition, assuming that the amounts of material employed in forming the compositions were the amounts given in Formula B of Macdonald patent No. 606,725, plus 64 pounds of carnauba, please state the amount of free stearic acid, expressed in pounds, which your analysis disclosed?

*A.* 122.5 pounds.

*rdQ.* 153. What, if anything, does this demonstrate as to whether or not there was any reaction between the stearic acid and the alleged free myricyl alcohol in the carnauba wax?

*A.* It is a practical demonstration that there has been no such reaction, for if there had been such a reaction to any appreciable extent my analysis would have shown a quantity of free stearic acid less than the quantity uncombined with the said oxides, but I find it is practically identical and cannot escape the conclusion that if the reaction took place at all it must have been to a very slight extent.

*rdQ.* 154. Professor, you have been asked in regard to the effect of adding a small amount of phosphorous to steel. Is phosphorous a substance analogous to steel? *A.* It is not.

*rdQ.* 155. Suppose you add to a mass of steel a small percentage of some analogous substance, such as another kind of steel, would this minute addition produce any appreciable effect upon the mass of the steel as a whole?

*A.* No, for the reason that the minute quantity added is a substance analogous to steel itself.

*rdQ.* 156. Is, or is not the compound ether formed by the reaction myricyl alcohol upon stearic acid analogous to the compound ether of which carnâuba wax is mainly composed?

*A.* It is analogous.

*rdQ.* 157. If a very small amount of wax-like compound ether such as would result from the reaction between myricyl alcohol and stearic acid, is added to a record composition, together with a vast and larger amount of wax-like compound ether such as that constituting the main body of carnauba wax, would it have any appreciable effect upon the composition as a whole and, if not, why not?

*A.* No, and for this reason. As I have before testified in this deposition that the compound ether that would be formed between the free stearic acid and the free myricyl alcohol is myricyl stearate. Myricyl stearate is a hydrocarbon compound having a position in the series of these compounds very near that of the compound ether, myricyl cerotate in the carnauba wax, and the nearer these compounds are in their carbon content, the nearer they are in their general properties, and where they are so near together as in the present instance the properties must be very closely alike. A further reason lies in this fact. The myricyl stearate alleged to be formed, it must be remembered, contains about half myricyl palmitate and this is the principal or largest constituent part of beeswax which the patent states may be used in place of carnauba wax.

RE-CROSS EXAMINATION, by Mr. DYER:

*rxQ.* 158. Is stearate of soda as it exists in these metallic soap compositions a stable or unstable combination?

*A.* No conditions are specified, and I presume the question refers to the stable or unstable combination of stearate of soda as it would result in carrying out the process of the patent in suit and after the resulting products of its formation had been removed by heat. Under these conditions it is my opinion that it can be properly called a stable combination, for the reason that the element sodium which is in the stearate of soda is one of the strongest electro-positive elements.

*rxQ.* 159. Have you ever made or identified myricyl stearate, the compound ether resulting from the reaction of stearic acid and myricyl alcohol? *A.* No, not as a separate body.

*rxQ.* 160. Have you ever made the experiment referred to in *rdQ.* 157? *A.* No.

Signature of witness and certificate of Notary wavied.

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WASHINGTON, D. C., Jan. 25, 1907.

Met pursuant to adjournment.

Present—FRANK L. DYER, ESQ., for Complainant; PHILIP MAURO, ESQ., for Defendant.

And thereupon SHELTON T. CAMERON, a witness produced on behalf of defendant, being first duly sworn, deposes and says in answer to questions propounded by Mr. Mauro:

*Q.* 1. Please state your name, age, residence and occupation?

*A.* Shelton T. Cameron; age, 49 years; residing at Washington, D. C.; and by occupation a lawyer, making a specialty of patent law, and mechanical expert.

*Q.* 2. What have been your education and experience that would qualify you to testify as an expert in patent causes, and particularly what is the extent of your of your knowledge and acquaintance with the art of recording and reproducing sounds and the manufacture of sound-reproducing instrumentalities, such as sound records, whether originals or duplicates?

*A.* I was educated at Emerson Institute in this city, and after taking the regular and post graduate course in law at Columbia (now George Washington) University and a subsequent course in constitutional law, I entered the United States Patent Office as an Assistant Examiner, where I remained for eight years. During that time it was a part of my daily duty to examine and pass upon applications for patents, make searches in the literature and prior art relating to the subjects-matter of the applications, etc. Over ten years ago I severed my connection with the Patent Office, and since that time have been continuously engaged in the practice of my profession. During that time I have prepared a great many applications for patents, rendered numerous opinions as to questions of infringement and the validity of patents, and repeatedly testified as a machanical expert in causes pending before the United States Courts. In connection with the various matters mentioned it has been necessary for me to repeatedly visit machine shops and manufactories to study processes and machines;

From the very beginning of the practice of my profession, more than ten years ago, I have been intimately acquainted both with the theoretical and practical art of recording and reproducing sound, and have prepared a great many applications for patents in this art and prosecuted the same before the U. S. Patent Office, as well as in foreign countries. In order to keep myself thoroughly in touch with all that was being accomplished in this art, I have repeatedly visited the factory of the American Graphophone Co., and there studied the processes of manufacture, including the process of making sound-record material, the making of original records by the direct action of sounds upon a diaphragm controlling the cutting style in contact with a suitable recording material, and also the processes of securing duplicates from the originals, which include both the mechanical cutting of duplicates and the molding of the same. In short, I have had unusual facilities for familiarizing myself not only with the theoretical and patent side of the art, but with the practical and commercial side as well.

I have also testified as expert in a great many suits in the U. S. Courts relating to the talking-machine art, among the more recent of which I may mention the cases of the American Graphophone Co. *v.* Universal Talking-Machine Manufacturing Co.; American Graphophone Co. *v.* American Record Co.; and the Victor Talking Machine Co. *v.* American Graphophone Co., recently decided in the U. S. Circuit Court for the Southern District of New York. Also two suits on the Edison molded record entitled National Phonograph Co. *v.* American Graphophone Co.

*Q*. 3. Please state the character of the material heretofore employed for making original and duplicate sound records, tracing a brief way the development of the art so far as the same relates to the composition employed for receiving the sound record, and particularly the cylindrical form of sound record?

*A*. The theoretical side of the art may be said to have had its inception in the indented tin-foil record patent of Mr. Edison No. 200,521 of February 19, 1878. This, however, was found inadequate for commercial use and therefore never went much, if any, beyond the realm of a scientific demonstration of the possibility of recording and reproducing sound.

The commercial art of recording and reproducing sound had its foundation in the Bell & Tainter patent of May 4, 1886 No. 341,214. Briefly stated, this patent consisted in cutting or engraving the record in wax or wax-like material by the action of a cutting style attached to a vibratory diaphragm upon which the sound waves to be recorded were permitted to impinge. The particular material disclosed in that patent as forming the sound-record tablet is "a waxy or amorphous and slightly cohesive substance, preferably, a compound of beeswax and paraffin, the latter in excess."

The record thus cut in the beeswax and paraffin record material by direct action of the sound waves upon the diaphragm was known as an "original record."

A little over two years later, viz., in 1888, Mr. Tainter took out patent No. 393,190 for a recording medium for talking-machine records in which he stated

> "A number of common waxes—such as beeswax for example—have certain properties that are advantageous and useful, but lack hardness and resistance to changes of temperature, and other conditions requisite to successful employment. Beeswax, for example, cuts smoothly, but is too soft and sticky. It has been found that waxes of this nature can be rendered suitable for the use desired by an admixture of a proper proportion of a substance known as 'carnauba-wax.' This wax itself is very hard and brittle, and, in cutting chips off in small particles; but it mixes readily with beeswax and waxes of like nature and forms a compound eminently suitable for the recording-surface of a graphophonic tablet."

In a subsequent paragraph the patent states:

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> "In preparing the mixture I take from 15% to 40% of carnauba wax to from 60% to 85% of the softer wax—such as white beeswax. The maximum proportion of carnauba wax is used in warm weather, and at high summer heat will render the mixture sufficiently hard. At more moderate temperatures a smaller amount of carnauba wax is preferably employed."

Mr. Tainter also, in 1890, took out patent No. 421,450 for a graphophonic tablet composed of ozocerite wax, in which he stated that in forming the tablet it was advantageous to concentrate the crude wax by the application of heat and after concentration by boiling the patent states that "the wax becomes harder and tougher" and changes in color "from a brownish black to a deep black;" and he also states that it is customary to employ "a temperature of 400° F. and upward," and that the duration of the treatment will depend upon the temperature employed.

The patent then states, page 2, lines 8-13:

> "The ozocerite wax may be employed alone, and it is sufficiently cheap for the purpose. It may, however, be combined with other waxes. It mixes readily with beeswax, carnauba wax and others, and its use in such compositions would be within the scope of the invention."

Prior to the date of this Tainter patent No. 421,450, Mr. Edison had also disclosed another wax-like composition for use as the record-receiving material. This was in patent No. 400,648, dated April 2, 1889.

After stating that the object of the invention is to produce bodies for phonogram blanks which shall be composed of a material having superior qualities for receiving sound-records and reproducing sounds therefrom, the patent states, lines 16-22:

> "I have found that various waxes are very desirable to use in the composition of such phonogram blanks, but that most waxes if used by themselves are too soft for this purpose. I therefore mix with the wax a harder material, which will produce a harder compound."

The patent then proceeds to state that stearic acid is an exceedingly desirable hardening material for this purpose, and that he may mix it with any suitable wax as ceresin, beeswax or paraffin. I quote claim 4 of this patent, which is as follows:

> "4. Phonogram-blanks made of a mixture of ceresin, beeswax, and stearic acid in about the proportions, by weight, of 100 parts of ceresin, 25 parts of beeswax, and 25 parts of stearic acid, substantially as set forth."

So far as I am aware, this is the first disclosure of the use of stearic acid in a sound-record composition.

A short time later, viz., on June 17, 1890, Mr. Edison took out patent No. 430,274, for phonogram blanks made of metallic soap formed of "any metal or some times of an earthy oxide like lime, in combination with any fatty acid." He states, however, that, it is best to use lead, magnesium or aluminium combined with oleic or stearic acid. If lead were used, this would result in a metallic lead soap and if aluminium were used it would result in a metallic aluminium soap. This metallic soap was "melted and poured into molds to form the cylindrical blanks."

Metallic soap is recognized in the art of recording and reproducing sound as a wax or wax-like material. Thus, in Mr. Edison's patent No. 484,583, he uses the following expression, page 1, line 22, et seq.:

> "The recording surface of the phonogram blank is ordinarily of wax or a stearate or hard metallic soap or *other wax-like material* or composition."
>
> (Italics mine.)

On the same date Mr. Edison took out a patent No. 484,582, in which he states, lines 8 to 19, that:

> "The object I have in view is to produce a practical process for the duplication of graphophonic records, so that the new art of phonographic publication can be established. Generally I propose to construct a suitable matrix, preferably in metal, and by its use mold duplicate phonograms with the phonographic records thereon, such phonograms or the surface thereof being preferably constructed of a material too hard for the satisfactory indentation thereof by the phonograph-recorder."

The "matrix" mentioned in this quoted clause, is obtained by covering an original record with a suitable electrical conductor, and then further providing a thicker covering of metal "by electro-plating the metal" upon the covering, and by then backing up the electro-plating in a suitable way so as to form a sufficiently strong mold. The material of the original record is then removed

> "leaving in the case of cylindrical phonogram a hollow metal cylinder or one internally faced with metal, carrying the phonographic record in relief upon its inner surface." (page 1, lines 65-69.)

The patent then states, lines 75 et seq., page 1:

> "The duplicate phonograms are produced by means of this mold by *pouring* therein and preferably around a suitable core placed in the mold suitable substances, such as wax or wax-like material, resin, or plaster of Paris, the material being preferably too hard to be satisfactorily indented by the phonograph."
>
> (Italics mine.)

I find in Mr. Edison's patent No. 488,191 a recognition of the equivalency in this art of fatty acids and wax or waxes. In this patent, taken out in 1892, Mr. Edison's object was to provide phonogram blanks or surfaces for receiving sound records, and he states that

> "There are many compounds of wax or wax-like material which may be employed for the purposes of my invention. What I prefer to use is a mixture of asphalt with Japan wax or pitches made from the distillation of fatty oils or combinations of fatty acids, any of which materials are equivalents of wax for the purposes of this invention." (page 1, lines 38-45.)

I find, therefore, from this review of the art that the materials heretofore employed for making sound records, whether duplicates or originals, are materials of a wax or wax-like character, and that in the art the equivalency of metallic soap and fatty acids with waxes such as beeswax, carnauba wax, ceresin and mixtures or compositions containing these, is fully recognized. I also find that it is recognized in the art that when a material is to be cut by the engraving style of the machine, it is desirable that it should have a certain degree of hardness, but that it should not be so hard as to offer too much resistance to the vibrating action of the style; and it is also recognized that when a material is to be molded to form a duplicate, as by melting it and pouring it into a mold formed by electro-depositing metal upon an original, the material may be, and preferably should be, harder than that which would be employed when the record is to be cut by a vibratory style under the influence of sound waves.

The materials to which I have referred in previous portions of this answer are materials used not only in the production of cylindrical records, but in the production of disc-like tablets as well. Other materials have also been suggested for the production of disc-like tablets alone, such, for example, as hard rubber, as set forth in the Berliner patent No. 548,623 of Oct. 29, 1895. This was a duplicate record, the lines corresponding to sound waves being impressed in the rubber when plastic, by means of a die or matrix. The patent does not say anything about the color of this hard rubber, but as a matter of practice in the art the record was a deep black, i. e., it was the color of the ordinary black, hard rubber, such as we see employed in combs and like articles. This black color is obtained by the use of a pigment, such a lamp black.

*Q.* 4. You have mentioned carnauba wax as being employed with other waxes and wax-like materials for a sound-record composition? Please state the purpose for which it appears carnauba wax has been thus employed, and the temperature or temperatures to which it was subjected in the preparation of the composition in which it is thus employed?

*A.* Carnauba wax has been employed in connection with other materials in the formation of sound-records as a hardening material for other waxes and wax-like materials, and also that advantage may be taken of its shrinking properties in passing from a molten to a hard or set condition. Thus, in the Tainter patent No. 393,190, mentioned above, it was employed because of the fact that it was "very hard" and was used to harden other wax-like materials, as beeswax, ceresin wax and bay wax. In this connection I note that 15% is indicated as the amount of carnauba wax which could be advantageously mixed with other softer waxes to secure the hardening result.

In Tainter's patent No. 421,450, carnauba is mentioned as a wax which could be readily combined with other waxes, such as ozocerite, and it is stated that the use of carnauba wax with the ozocerite is contemplated as being within the scope of the invention of that patent. The patent states that in forming a tablet of ozocerite wax it is concentrated by boiling, becoming harder and tougher and changing in color from a brownish black to a deep black, and that in its treatment it is customary to employ a temperature of 400 degrees F., and upwards. Presumably the same treatment and results would be employed and occur when the composition of carnauba and ozocerite is used, as mentioned in the patent.

Mr. Edison in his patent No. 406,576 states that in making a phonogram blank he prefers to mix with asphalt or bitumen

> "a small percentage of a material which in solidifying shrinks or contracts greatly, such as certain waxes, and preferably carnauba wax." (page 1, lines 68-71).

I find, therefore, that carnauba wax has been employed in connection with other sound-record materials in proportions ranging from a small percentage, 15%, up to 40%, for the purpose of hardening the record material and for taking advantage of its property of shrinking.

*Q.* 5. Do I understand that you say that in the art of recording and reproducing sound metallic soap has been recognized as a wax-like material for the formation of sound-records? If so, please state where and how such recognition occurs?

*A.* As I stated in my answer to *Q.* 3, Mr. Edison in his patent No. 484,583 distinctly recognizes metallic soap as a wax-like material for the recording surface of phonograph blanks, since in the recitation of the substances employed he mentions ordinary wax, stearate, a hard metallic soap "or other wax-like material or composition." (See lines 22-26, page 1.)

*Q.* 6. I believe you stated that you found in the art a recognition of fatty acids as a wax or the equivalents of a wax for the composition of sound records. Please state where you find such equivalency recognized?

*A.* In Edison's patent No. 488,191, in which he mentions a number of materials, among which are "combinations of fatty acids, any of which materials are equivalents of wax for the purpose of this invention."

*Q.* 7. In your answer to *Q.* 3 you mention a disclosure in the art of the formation of duplicate sound records by molding hard wax-like material by pouring the same in a molten state in molds secured by an electro-deposit of metal upon an original record. Please indicate where such disclosure is made?

*A.* In Edison's patent No. 484,582. This patent specifically points out that the object is to produce a practical process for the duplication of phonographic records and that the surface thereof, i.e., of the duplicate record, "is preferably constructed of a material *too hard* for the satisfactory indentation thereof by the phonograph-recorder." (Italics mine. Lines 17-19, page 1).

After describing the formation of the mold by electro-deposition of the metal upon the original record, the patent states that the phonograms are produced by means of this mold by "pouring" therein suitable substances "such as wax or wax-like materials." The material being preferably too hard to be satisfactorily indented by the phonograph. Wax or wax-like materials which in their normal state are too hard to be satisfactorily indented by the phonograph (which is an expression frequently used by Mr. Edison when he means to be satisfactorily cut by the cutting style of the graphophone) cannot be *poured* except when in a molten condition, and this statement in this Edison patent clearly contemplates reducing the hard wax or wax-like material to a molten condition before it is poured into the mold. I therefore find in this Edison patent a disclosure of the formation of duplicate sound records by molding a hard, wax-like material (in fact too hard to be satisfactorily cut by the recording style) by pouring the same in a molten state into a mold secured by an electro-deposition of metal upon an original record.

*Q.* 8. If you find in the art any disclosure of a sound-record material composed of a metallic soap comprising stearate of soda, aluminate of soda, free stearic acid and a tempering wax, such as ceresin or its equivalent, please state where such disclosure occurs; and in case you can do so indicate the temperatures employed in the manufacture of the composition?

*A.* In the patent granted to Mr. T. H. Macdonald, No. 626,709 on June 13, 1899, there is disclosed a formula for making a sound-record composition or material which employs stearic acid, aluminic hydrate and caustic soda lye which, I understand, would result in the formation of a metallic soap comprising stearate of soda and aluminate of soda. To this there is also added "for the purpose of tempering" paraffin or similar material. Ceresin as a tempering wax is recognized in the art as the equivalent of paraffin. During the initial part of the process, the temperature of about 240 degrees F. is said to be employed, after which the temperature of the molten mass is raised "to a point somewhere between 450 degrees and 475 degrees F."

*Q.* 9. How hard would be the composition referred to in your last answer?

*A.* The object of the invention set forth in Mr. Macdonald's patent was to obtain a suitable material for blanks or tablets "upon which sound records may be cut or engraved," and of course from which the sound records thus cut or engraved could be reproduced by the action of a reproducing style rubbing over the cut record. The material must not, therefore, be too hard to be suitably cut by the engraving style, while on the other hand it must be as hard as it could well be and yet not interfere with the cutting action of the recording style.

*Q.* 10. Suppose it was desired to have the composition referred to in the Macdonald patent No. 606,725, harder. What, if anything, is there in the teachings of the prior art that would inform the expert in this art how to harden the compositions without interfering with or detracting from the properties of the composition necessary or desirable in a composition for molded sound records?

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*A.* This question leads to a discussion of what are the "necessary or desirable" properties in a molded sound record, and I find in the teachings of the prior art quite a large number of properties mentioned as desirable, for instance, the liquidity or mobility of the liquid when in a melted state. This is a condition which has sometimes been referred to as "a limpid condition," or the quality of "limpidity." It is recognized in the art that this condition may be obtained in a composition by adding a small quantity of wax having a low melting point, such as ozocerite or ceresin. Indeed this has been employed in compositions in connection with carnauba wax, so that carnauba wax is not calculated to destroy the quality of limpidity secured by a tempering wax, such as ceresin. It is also recognized that the composition should be amorphous and noncrystalline, and should be free from products of decomposition, as well as have a fine texture. All of these qualities would be found in the metallic soap composition of the Macdonald patent No. 626,709 of June 13, 1899, which I have before mentioned. It will be free from decomposition products and be perfectly amorphous and non-crystalline and with a fine texture or grain because of the high temperature employed which would tend to destroy the decomposible products and drive off the water of crystallization, thereby rendering the composition amorphous and non-crystalline. It would have a fine texture because of the concentration due to the prolonged high temperature. Moreover, experience has taught that it does not stick or adhere to the mold, and that it is capable of shrinking away from the mold when quite hard by reduction in temperature; and these are very desirable qualities in a sound-record composition. Its fine texture and limpidity enable it to take perfectly the impression of the matrix or mold, and if this is a polished surface, the resulting duplicate will have a smooth and polished surface. This record of a smooth surface also includes the absence of any pits or small depressions due to the presence of air-bubbles. The elimination of the air and gas bubbles is obtained in the Macdonald composition by the high temperature which expels all air and gas in the material before it is molded. Experience has taught that records molded from this material shrink away from the mold without warping so as to render it incapable of use on standard talking-machines. The material should not be affected by moisture, and this desirable quality is obtained by the presence of the ceresin wax which wax is non-hygroscopic. It is desirable that it should have a high melting point which, as I understand it, is but another way of saying that it should be hard. The presence of the metallic soap itself means a hard material, the metallic soap being largely composed of stearic acid which, as Mr. Edison stated in his patent No. 400,648 "is an exceedingly desirable hardening material." In fact, it is desirable that it should be even harder than metallic soap, and it is for this reason that the carnauba wax is added. In regard to color, the record should be any color suiting the taste or demand of the trade, and this can generally be obtained by the addition of any suitable pigment. That which has hertofore been employed in the art, viz., lamp black could be employed if a black color was desired. The material should be tough and smooth in texture, this being a quality which has been recognized as desirable for more than fifteen years.

From the numerous teachings in the prior art and particularly from the teachings of the Tainter patents Nos. 393,190 and 421,450 an expert in the art would know that if he wished to make a record material of the Macdonald patent No. 626,709, harder, that he could do so by adding carnauba wax thereto. He would know that this would not interfere with but would possibly slightly increase the shrinking properties of the composition, from the teachings of the Edison patent No. 406,576. And moreover he would know from the same patent that it would not interfere with the limpidity imparted to the composition by the ceresin wax. Moreover, he would have been taught by the Tainter patent No. 393,190 that it would not interfere with the fine texture which would enable the material to be cut smoothly, and that the material would be free from the air and gas bubbles because of the prolonged high temperature to which it was subjected.

Answering your question therefore in a single sentence I would say that the teachings of the prior art would tell the expert that he could harden the material of the Macdonald patent No. 606,725 by adding carnauba wax thereto in proportions varying from a small percentage up to 15% or higher, and that this hardening effect could be obtained without interfering with or detracting from the desirable properties of the composition for molded sound records.

*Q.* 11. Have you read the Aylsworth patent in suit No. 782,375, and do you understand the same?

*A.* I have read the patent in question and believe I understand it.

*Q.* 12. Have you read and do you understand the depositions of complainant's experts, Browne and Aylsworth herein?

*A.* I have and do.

*Q.* 13. Have you read and do you understand the depositions of defendant's witnesses Macdonald, Thornberry and Prof. Holton herein? *A.* Yes.

*Q.* 14. Please state briefly what alleged invention you find to be described and claimed in the Aylsworth patent in suit with particular reference to claims Nos. 1–10 inclusive, 12, 14, 16, 18, 19, 20 and 22?

*A.* The invention described in the patent in suit relates to a composition adapted particularly to the making of duplicate phonograph records obtained by any suitable process from a matrix or mold, and it is alleged that the composition may be effectively utilized for the manufacture of duplicate phonograph records obtained by means of any process where a material in a molten or plastic condition is introduced into a matrix or mold and is allowed to set, *or* is expanded therein so as to take an impression, the material being removed by diametric shrinkage so as to clear the mold.

The patent sets forth a long catalogue of alleged "peculiarities" which a composition of this character should have. It is not necessary for me to go further into this catalogue of peculiarities than to say that without exception every one of them is one which has been recognized as more or less desirable in the art prior to the date of the Aylsworth patent, some of them being substantial essentials and others being more or less desirable. In describing a method of making the improved composition the patentee states that he takes 100 pounds of "commercial stearic acid" which, he states, is a mixture of stearic and palmitic acids, and I learn from Mr. Aylsworth's deposition, and also from Prof. Holton's, that stearic and palmitic acids are substantially in the proportion of 50% each. It is stated that the stearic acid should be free from certain impurities, such as oleic acid, glycerine, undecomposed fats, etc., and that after being melted there is added to the same a water solution of carbonate of soda and aluminate of soda. This, the chemists inform me, will produce a metallic soap consisting of stearate of soda and stearate of alumina, and the patent conveys the additional information that the composition in addition to this metallic soap will have an additional amount of free stearic acid present. To this metallic soap containing free or excessive stearic acid there is added a suitable amount of "a very hard wax, preferably carnauba," the amount mentioned in the formula of the patent being 21.36 pounds. After the carnauba wax is added to the mixture, the temperature of the mass is raised to about 450 degrees F. and maintained at that temperature, usually for about five hours. It is alleged that by maintaining the composition at this high temperature after the carnauba wax has been added, there are certain chemical reactions which take place between "the alcohol of the carnauba wax" and the excessive or free stearic acid present, forming "a hard wax-like compound ether"; and it is alleged that this hard, wax-like composition, thus stated to be formed by the combination of the alcohol of the carnauba and the free stearic acid "gives to the composition many of its desirable characteristics." What the particular characteristics are which are thus alleged to be imparted to the composition, we are not told, unless it be found in the statement that the composition would be brittle and shrink excessively if the high heating is not effected, and that there would be a greater likelihood of decomposible products remaining in the composition which would result in the presence of bubbles on the surface of the resulting duplicate.

After the treatment by this high temperature has been effected, the patent directs that 21.36 pounds of ceresin or equivalent hydrocarbon wax be added. It is alleged that the "purpose" of adding the hydro carbon wax is to render the mixture non-hydroscopic and less brittle.

As equivalents to a greater or less extent of carnauba wax the patent mentions beeswax, Chinese wax and palm wax. The patent also states that after the ceresin is added "the congealing temperature of the latter (mixture) may be regulated by adding free stearic acid thereto." We are told, however, in Mr. Aylsworth's deposition that the amount of stearic acid added " is simply replacing that which evaporates during the manufacture of the composition."

Stripped of all the chemical phrases and verbiage employed, which appear to be present more for the purpose of mystifying the desription contained in the patent than for describing any real features of the invention, this all means that Mr. Aylsworth takes a metallic soap composition consisting of stearate of soda and stearate of alumina, with an additional per cent of free stearic acid, and adds thereto ceresin wax to temper it and render it non-hygroscopic, and also adds carnauba wax thereto to make it harder.

The statement of the formula employed and the particular mode of procedure in making the composition is merely for the purpose, as I understand it, of explaining the best method known to the applicant for making the composition which is the alleged invention claimed, and which, as I understand it, would be satisfied by any like composition whether it was obtained by the specific method set forth in the patent in suit or not.

Thus, in claim 1 we find defined a composition for phonograph recording surfaces "comprising a metallic soap and a hard wax added thereto," and the second claim is precisely the same except that the hard wax is here defined as being specifically carnauba wax. The third claim merely specifies the addition of a non-hygroscopic ingredient to the metallic soap and hard wax composition of claim 1, and claim 4 differs from claim 3 only in that the non-hygroscopic ingredient is specified as being ceresin. Claims 5 and 6 are the same as claim 2, except that in one there is a non-hygroscopic ingredient added to the composition of claim 2, while in the other this non-hygroscopic ingredient is specifically defined as being ceresin.

Claims 7, 8 and 9, instead of the hard wax or carnauba wax of the first six claims, mention "a wax-like compound ether" and only differ from each other in that they ring the changes on the presence or the absence of the ceresin, whether defined as such or as the non-hygroscopic ingredient. Claim 10 is but a repetition of claim 1, calling for a metallic soap and a hard wax, with the addition of a black pigment. Claim 12 amounts to the addition of a black pigment to the metallic soap and carnauba wax of claim 2, and claim 12 is simply the addition of a black pigment to the metallic soap, carnauba wax and ceresin of claim 6: claim 16 adds a black pigment to the metallic soap and wax-like compound ether composition of claim 7. Claim 18 differs from claim 5 only in that it specifies the "metallic soap" of claim 5 as being "stearate of soda" and claim 19 is claim 6 with the "metallic soap" of the latter claim defined as "stearate of soda." Claim 20 is claim 12 except that the "metallic soap" of the latter claim is defined as "stearate of soda." Claim 22 defines a mixture of stearate of soda, stearate of aluminium, carnauba wax, the stearate of soda and stearate of alumina being the metallic soap of claim 2.

As I have previously stated in this deposition, the use of a hard wax-like material as a composition for molding duplicate sound records is old, as set forth for instance in Edison's patent No. 484,582 of 1892, the material of this patent being described as "preferably too hard for satisfactory indentation by the recorder." And, as I have before stated, metallic soap is recognized as a wax-like material in this art and is specifically referred to as such in Mr. Edison's patent No. 484,583, so that when he speaks in his patent No. 484,582 of using "wax or wax-like material he necessarily includes as one of the equivalents substance the metallic soap which, in his patent No. 484,583 taken out on the same day, he speaks of as a wax-like material for sound-records.

Now, the addition of carnauba wax to a wax-like record material has been known in the art almost from its inception, for the purpose of hardening a composition material which was found to be softer than was desired for the special purpose in view. For example, it is clearly disclosed in the Tainter patents Nos 393,190 and 421,450, to which I have heretofore referred, and in the latter of which the statement is made that the material may be heated to 400 degrees F. and upward. Not only is metallic soap, broadly speaking, well known at the date of the patent in suit as a record material, but the specific metallic soap mentioned, containing stearate of aluminium, had been disclosed as early as 1890 by Mr. Edison in his patent No. 430,274. I am not a chemist and make no professions whatever to the possession of chemical knowledge, but I understand that the combination of fatty acids and an oxide of aluminium would produce an aluminium metallic soap, and if stearic acid be employed it would produce a stearate of aluminium.

Further, I find that as early as 1899, there was described in the patent to Macdonald No. 626,709, a process of making a sound-record composition by the use of stearic acid, aluminic hydrate and caustic soda lye which would result in the formation of a metallic soap composed of stearate of soda and stearate of alumina. Now, so far as claim 1 is concerned, it simply defines the addition of a hard wax to any one of these old metallic soaps, and claim 2 defines the addition of a specific hard wax, that is carnauba wax, to any one of these old metallic soaps. In fact, whether the metallic soap be the lead soap of the Edison patent No. 430,274, or the stearate of soda and the aluminate of soda metallic soap of the Macdonald patent No. 626,709, all of claims 1 to 6 inclusive would consist, so far as the hard wax or carnauba wax is concerned of simply adding such wax to this old metallic soap for the old and well-known purpose of hardening the metallic soap (wax-like composition) well known in the art.

So far as those claims are concerned that call for the presence of a non-hygroscopic ingredient or ceresin, this is also clearly disclosed in Macdonald patent No. 626,709 in which paraffin is added as a tempering and non-hygroscopic ingredient; and paraffin is recognized in the patent in suit as being an equivalent of the ceresin.

Claims 7, 8 and 9 speak of "a wax-like compound ether." I am informed, however, in the depositions of complainant's expert, Mr. Aylsworth, and defendant's expert, Prof. Holton, that carnauba wax consists largely (and Prof. Holton says essentially) of a wax-like compound ether, so that when carnauba wax is added to a metallic soap there is necessarily added a wax-like compound ether. That the wax-like compound ether of the carnauba wax is not destroyed or broken up by any chemical action by the process set out in the specification, is rendered clear by two things: first, Mr. Aylsworth himself tells us that it is not, in his deposition; and, second, if it were destroyed or broken up, then his resulting composition could not be said to contain a wax-like compound ether, unless such a wax-like composition were formed in the manner set out in the patent in suit. I am informed by the deposition of Prof. Holton, defendant's expert herein, that it is demonstrable that there is no wax-like compound ether formed by any free alcohol in the carnauba wax uniting with the stearic acid in excess in the composition, unless possibly it be such a small amount as to be entirely negligible in the composition as a whole.

However this may be, it is apparent that if carnauba wax consists chiefly or largely of a wax-like compound ether (and on this point I understand there is no dispute) then the addition of carnauba wax to the metallic soap would give a mixture of a metallic soap and a wax-like compound ether. But as I have before pointed out, it has long been well known that the addition of carnauba wax to a wax-like sound-record material, such as metallic soap, should be made when it is desired to harden the composition.

From the foregoing it will be seen that claims 7, 8 and 9 would be responded to by the addition of carnauba wax to the composition of the Macdonald patent No. 626,709, consisting of a metallic soap and paraffin (which is the equivalent of ceresin).

In this connection I would mention that the identical temperature mentioned in the patent in suit, viz., 450 degrees F., is also indicated in the treatment of the composition of the Macdonald patent No. 626,709. So that, if following the teachings of the prior art, carnauba wax be added to the composition of the Macdonald patent without changing or in any way altering the procedure set out in said patent, carnauba wax would be subjected to the same treatment specified in the patent in suit, and particularly the same temperature.

Another view to take of the matter is that the Macdonald patent No. 606,725 of 1898, sets forth a process of making a metallic soap consisting of stearate of soda and stearate of alumina with excessive or free stearic acid present, and to which is added the tempering and non-hygroscopic ingredient, ceresin of the patent in suit, and that claims 1-9 inclusive merely call for the addition of the hardening carnauba wax to the composition of Formula B of said Macdonald patent No. 606,725.

The additional claims declared upon, 5, 10, 12, 14, 16, 18, 19, 20 and 22 all, with the exception of 18, 19 and 22, simply call for the addition of a pigment, viz., lamp black. As I have already stated, this was well known in the art of making sound-record material, for example, in the addition of lamp black to hard rubber which had been employed as a record material. But even if this were not the case, it is clearly within the province of the expert mechanic in this art to add a coloring material or pigment to produce any desired color in the resulting composition.

Referring to claims 18, 19 and 22, the first—18— merely amounts to the addition of carnauba wax to the composition resulting from either one of the Macdonald patents Nos. 606,725 or 626,709 as the prior art has clearly taught might be done if it were desired to harden the composition. The same is true of claims 19 and 22.

*Q.* 15. Was it novel at the date of the patent in suit to add carnauba wax to a sound-record composition for the purpose of hardening the same?

*A.* It was not. This was clearly disclosed in Tainter patent No. 393,190 for the express purpose of hardening the composition. Moreover, it appears that the identical percent of carnauba wax, or substantially the identical percent mentioned as being added, by defendant to its composition (see Macdonald's deposition, *Q.* 25), viz., 15%, is mentioned as the proper amount in the Tainter patent No. 393,190.

Furthermore, in Tainter patent No. 421,450, the addition to carnauba to the sound-record composition is mentioned, though not expressly stated to be for the purpose of hardening.

*Q.* 16. Was it novel at the date of the patent in suit to add wax-like compound ethers to a sound-record composition for the purpose of hardening the same? In answering this question it may be assumed that carnauba wax contains wax-like compound ethers which would not be broken up or destroyed by a temperature of 450 degrees F.

*A.* It was not novel at the date of the patent in suit to add wax-like compound ethers to a wax-like sound-record material for the purpose of hardening the same, if I may assume, as the question says I may, that carnauba wax is composed of or contains wax-like compound ethers, since carnauba wax had been added to a wax-like sound-recording material as early as 1888 (see Tainter patent No. 393.190, before mentioned).

CROSS-EXAMINATION by Mr. DYER:

*xQ*. 17. You are the partner, are you not, of Mr. Massie who appears as counsel in this case?

*A*. Mr. Massie is one of my partners. If he appears as counsel in this case I do not know it.

*xQ*. 18. Did you not observe in reading Mr. Aylsworth's deposition that Mr. Massie represented the defendant as counsel?

*A*. I did not. I paid very little attention to the preliminary parts of the deposition. My understanding of the matter is that in the absence of defendant's counsel, Mr. Mauro, Mr. Massie was employed to represent him at the cross-examination of defendant's witnesses, Browne and Aylsworth, and it is quite possible that his name may have been entered as of counsel.

*xQ*. 19. I show you a copy of the answer furnished me in this case, from which it would appear that Mr. Massie is of counsel herein, and I will ask if that is not his handwriting and signature?

*A*. It does, and the signature is that of Mr. Massie. At that time, however, Mr. Massie was a partner of Mr. Mauro, and at the present time he is not.

*xQ*. 20. Do I understand that Mr. Massie, your partner, has withdrawn as counsel in this case?

*A*. I am unable to state what you understand.

*xQ*. 21. Is it your understanding that your partner, Mr. Massie, has withdrawn as counsel in this case?

*A*. I really do not know. Further than that I understand that he is still employed by Mr. Mauro in connection with the case.

*xQ*. 22. You are a member of the firm of Mauro, Cameron, Lewis & Massie, are you not?

*A*. I am a member of a firm practicing under that name.

*xQ*. 23. I judge from the qualifications which you have set out on the record that you appear in this case in rather more than the usual capacity of a patent expert, skilled in the explanation of the technicalities of patents and of inventions, and that you also appear somewhat in the position of a practical expert familiar with the molded record art and with compositions for use in that art? Have I correctly stated your position?

*A*. Not quite. I appear as an expert accustomed to explain the technicalities of patents, and as one especially skilled as the result of long experience in the patented art in relation to talking machine and sound-recording instrumentalities. Necessarily my long and intimate connection with the patent side of this art has afforded me considerable opportunity to become more or less familiar with the practical side thereof. But I am frank to say that there is very much in the practical side of the art which I do not know.

*xQ.* 24. Then the statement in answer to *Q.* 2 that

> "In short, I have had *unusual* facilities for familiarizing myself not only with the theoretical and practical side of the art, but with the practical and commercial side as well." (Italics mine.)

is not to be taken as meaning that you are a practical expert, familiar with the practical difficulties of the art, or with the practical experience of the art in dealing with those difficulties?

*A.* No. My statement was meant to convey the idea that I have had more than the ordinary opportunity to familiarize myself with the patented, theoretical and the practical all combined. I think that few men except yourself have had greater opportunity to familiarize themselves with the practical side in connection with the patented and theoretical side.

*xQ.* 25. I appreciate your compliment, but since you have referred to me, is it not a fact that much of your deposition, so far as it consists of argument, is based on the usual considerations adopted by patent experts, that is to say, upon the patents and literature of the art, rather than upon the experiences and vicissitudes of the practical workings in the art?

*A.* I have sought to keep my deposition free from argument, except in so far as the statement of the facts might be said to constitute argument. In response to questions asked me by defendant's counsel I have set forth the state of the art as disclosed in the patents, but I have been materially assisted in my full and complete understanding of these patents by knowledge gained in the factory of the vicissitudes met with and overcome in the practical application of theories. In fact I have had the benefit of a long acquaintance with both Messrs. Bell and Tainter, whose work lies at the foundation of the art, and Mr. Macdonald, who has done so much to advance the art, and have repeatedly discussed with them the difficulties which they encountered and the practical methods to which they resorted to overcome these difficulties. Of course, one who has long been familiar with an art of this kind, and has done much on the patented side, as I have, and become more or less intimately acquinted with those connected with the practical commercial operations, absorbs a considerable mount of informatoin of a character which it would be difficult to classify on either one side or the other of the line dividing the purely theoretical and the practical:

Adjourned to Saturday, January 26, 1907, at 10.00 A. M.

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WASHINGTON, D. C., Jan. 26, 1907.

Met pursuant to adjournment.

Parties present as before.

(Mr. DYER proceeds with the cross-examination of Mr. CAMERON):

*xQ*. 26. Do you find any disclosure in the prior art of a composition possessing all the properties set forth in the patent in suit as being possessed by a desirable molded record material?

*A*. Yes. The material of either one of the Macdonald patents Nos. 606,725 and 626,709 both possess all of the properties mentioned in the patent in suit insofar as the statement of these properties is intelligibly made in the patent in suit. The material of both of these patents is hard, though not as hard as would be the material of the patent in suit. It therefore possesses the property, though not in this instance in the same degree. The property or quality, if such we may call it, of being dark or black was not present in all of the records made by the materials of the Macdonald patents, but I have repeatedly seen large numbers of records made from these materials that were almost if not entirely a deep black. I was struck by the difference in the records made under the Macdonald process so far as the matter of color was concerned and inquired into it, and found that when the material was freshly made up the records would be of a very much lighter color. In the practice of the process, however, shavings or records broken during the manufacture were returned to the melting pot and the result was a very much darker record. So far as the dark color however was due to the addition of any was concerned, a pigment is not present in the Macdonald compositions as made under the patents mentioned. Treating the term "limpid" as meaning liquidity or mobility the composition of the Macdonald patents possesses this quality. It was free from decomposition products, was of a very fine texture, was not sticky or tenacious so as to adhere to the mold, is capable of shrinking away from the mold when quite hard by a reduction in temperature, had a smooth polished surface, was free from air and gas bubbles, and it would shrink without undue warping. And I only use the word "undue" because I have never tested the records to say that they were absolutely true, though for all practical purposes they were. By reason of the presence of the ceresin they were not affected by moisture. A "high" melting point is a relative term, and is only another way of saying that the material was hard, since the softer the material as a rule the lower will be its melting point; they were capable of being cleaned cut and reamed; many of them, as I have above stated, were very dark in color, and by reason of the water of crystallization being driven out, they were amorphous and non-crystalline. In fact, it was necessary that they should have practically all of these qualities in order that they could be successfully employed for molding durable sound records, and the fact that they were successfully employed for this purpose is itself a demonstration that they possess the properties referred to.

*xQ.* 27. Except so far as the degree of hardness is concerned, then, you regard the metallic soap compositions that are described in the two Macdonald patents as possessing all the other properties that are set out in the patent as characterizing the Aylsworth composition?

*A.* Yes, and the Macdonald composition possessed the quality of hardness, though not to the same degree. Of course, we understand that the records made of this composition are uniformly black in color.

*xQ.* 28. And, I take it, your deposition has been given from this point of view, namely, that the metallic soap composition of the two Macdonald patents possess all the desirable requisites that are set forth in the patent in suit, except the special degree of hardness of the Alysworth composition?

*A.* I am not aware that my deposition has been given from any particular "point of view" upon the question as to whether or not the Macdonald composition possessed the qualities mentioned. My experience with them has taught me that they do.

*xQ.* 29. What experience have you had with the Macdonald compositions on which you base your opinion?

*A.* I have seen the composition compounded. I have followed the composition during its treatment in the melting pots with more or less care. I have seen the composition molded into sound-records. I have observed the conditions of liquidity or mobility. I have both cut and broken the molded material to determine its texture. I have kept them for a long time in a moist climate where other materials showed the effect of the moisture. I have studied the material under the microscope. I have observed the action of the material when molded in shrinking from the mold, and have observed that while it is still hot—though set—it did not shrink away from the mold so as to free itself from the mold, but that upon a reduction of temperature it did so free itself. I have observed that it came cleanly and freely from the mold; I have examined numbers of the records on different occasions and found them to present a smooth, polished surface, free from air and gas bubbles; I have observed that the material while still hot could be cleanly cut; and have particularly inquired into the amorphous or non-crystalline conditions of the records, and have learned the reasons for this amorphous, non-crystalline condition.

*xQ.* 30. Is this as far as your experience has gone with this composition?

*A.* No, I have observed the wearing conditions of the records made from the composition, though I have not conducted any extended and exhaustive experiments in this direction. Most of my knowledge in regard to the wearing conditions has been obtained from statements made to me by those connnected with the factory during my repeated visits. As I now recall, however, this is a fairly complete statement of my experience in connection with the record material referred to.

*xQ.* 31. When did you make the observations you have above set out in connection with the metallic soap composition that are described in the two Macdonald patents?

*A.* They were made from time to time as I visited the factory of the American Graphophone Co. I could not undertake to give you the exact dates, further than to say that these visits have extended through a series of years, and as each step in the development of the production of duplicates was taken in the practical operations in the factory, I would sooner or later familiarize myself with the *modus operandi* that was followed.

*xQ.* 32. Now, adopting your aspect of the case, let us assume that the metallic soap composition possesses many desirable qualities which should be possessed by an ideal molded record composition, except that it is not hard enough. I suppose you will admit that in making it harder nothing should be done that would detract from the desirable properties already possessed by the metallic soap composition?

*A.* Whatever is done to harden the material should not be done in such a way as to deprive the material of any of its essential characteristics, nor to reduce the degree in which it possessed these characteristics to such a point as to cause any deterioration in the quality of the finished product.

*xQ.* 33. Suppose it were attempted to harden the metallic soap composition by adding purified asphalt thereto. Would a desirable molded record composition result?

*A.* So far as I am aware the teachings of the prior art do not disclose anything that would serve as a criterion which would enable the expert in the art to know beforehand what the result would be in adding purified asphalt to the material, so that with purified asphalt the expert would be in quite a different position from that which he occupies in regard to carnauba, viz., he would have to experiment to find out. I therefore answer your question by saying that I do not know.

*xQ.* 34. Do you find any statement in the prior art of the use of carnauba in connection with a metallic soap composition?

*A.* I find the use of carnauba in connection with record material which is recognized in the art as the equivalent of metallic soap in a record composition. By this I do not mean that all or any wax-like material heretofore used in the art as a record material is identical in quality and characteristics, nor even as desirable as metallic soaps made in a certain way. But I do find that it is recognized in the art that metallic soaps are wax-like materials. And that carnauba wax may be, and has been, used to harden such wax-like material without detracting from the other desirable properties which they possess for this purpose. I therefore conclude that the teachings of the prior art were such that whenever it was suggested to an expert that it was desirable to harden the metallic soap composition he would know at once, and without experiment, that by adding carnauba wax to the composition he would obtain the desired hardening effect without detracting from the other desirable properties of the composition as a whole. The fact that Mr. Macdonald, who is an expert in this art, at once added carnauba to the record material when he desired to harden it, and that before the date of the patent in suit, is itself an illustration of my statement that an expert in the art would know that the carnauba wax could be added without detraction from the desirable properties which the material possessed.

By Mr. Dyer—Answer objected to as not responsive, and as based on hearsay.

*xQ.* 35. But you do not find in the prior art any specific reference to the use of carnauba wax with a metallic soap composition?

*A.* I do not.

*xQ.* 36. In answer to *xQ.* 34 you refer to "the equivalent of metallic soap in a record composition." What do you there have in mind?

*A*. In the art of recording and reproducing sound, metallic soap is recognized as wax or wax-like material, and I find in the art that carnauba wax has been mixed with other waxes or wax-like materials than metallic soaps, viz., the beeswax of Tainter patent No. 393,190 and the ozocerite of the Tainter patent No. 421,450. It was to the disclosures in these two patents that I refer.

*xQ*. 37. Your position then is, as I understand it, that since the addition of carnauba to beeswax and ozocerite had been suggested in the art, and since in the prior art the equivalents of metallic soaps and wax-like materials for record compositions had been suggested, it would be obvious that the carnauba wax could be added to a metallic soap composition without affecting its desirable characteristics as a composition for making molded records; is that correct?

*A*. Yes, coupled with the general knowledge as to the effect which carnauba wax has when mixed with other waxes. It was known, for example, that carnauba wax would not injuriously affect or detract from the quality of liquidity or mobility of the mixture when in a molten condition. It was known that it would not render it any more sticky but in fact would render it less sticky. It was known that it would make the material harder. The peculiarities or quality of being free from decomposition products, amorphous or non-crystalline, fine texture, freedom from air and gas bubbles—were not due to anything in the carnauba wax but to the heat employed and the presence of the ceresin or equivalent wax, such a ozocerite. It was known that carnauba wax when mixed with other waxes that were softer and had a lower melting point, would harden such waxes and increase or raise the melting point. I think, therefore, that the knowledge which the expert in the art had in regard to the action of carnauba wax in connection with beeswax and ozocerite, would furnish an excellent criterion as to what it would do with other analogous or wax-like substances, such as metallic soaps, and particularly when the substance is not one consisting entirely of metallic soap but, to a large extent, of free stearic acid—another recognized wax-like material.

*xQ*. 38. I direct your attention to Edison patent No. 488,191 of Dec. 20, 1892. This patent describes, does it not,

> "A mixture of asphalt with Japan wax or pitches made from the distillation of fatty oils or combinations of

> fatty acids, any of which materials are equivalents of wax for the purposes of this invention."

*A.* The quotation contained in your question is found in the patent referred to.

*xQ.* 39. Now, if this Edison patent states that asphalt (which Prof. Bolton says is a hard material) may be mixed with Japan or fatty acids (of which stearic acid is the commonest example in the art), why would it not follow by your reasoning that asphalt could be advantageously mixed with a metallic soap composition? *A.* Perhaps it can be.

*xQ.* 40. Whether it could or not would, I suppose, depend upon experiment?

*A.* So far as I personally am concerned, it would. But what this disclosure might teach to others more familiar with the action of asphalt than myself, I could not state.

*xQ.* 41. Suppose it were attempted to harden a metallic soap composition by the addition of a very fine precipitate, such as chalk. Would that result in a desirable composition for the molded art? *A.* It might and it might not.

*xQ.* 42. Whether it would or not would depend upon experiment?

*A.* So far as I personally am concerned, it would, though whether it would or not with one more familiar with the action of chalk in connection with wax-like compositions than I am, I could not say.

*xQ.* 43. Suppose it were attempted to harden a metallic soap composition by the addition of slacked lime. Would that make a desirable molded record material? *A.* I do not know.

*xQ.* 44. That also would depend upon experiment, I suppose?

*A.* With me it would, but with others more familiar with the action of lime on wax-like materials it might and it might not.

*xQ.* 45. Without asking a separate question as to each material, please refer to the ingredients mentioned in *xQ.* 66 of Prof. Holton's deposition, and state whether if any of the other materials not already referred to, with the single exception of carnauba wax, were added to a metallic soap composition in the attempt to harden the same, the resulting composition would be a suitable material for the molded record art?

*A.* The next ingredient to carnauba mentioned in *xQ.* 66 of Prof. Holton's deposition is metallic soap. Whether or not this would result in hardening the metallic-soap-ceresin composition, I should say would depend upon whether the metallic soap added for hardening purposes was harder than the metallic-soap-ceresin composition to which it was added. As to whether celluloid or glue could be successfully added, I do not know. I would make the same answer in regard to the two broad expressions "resin, rubber." Stearic acid, assuming that it is the same stearic acid that is in the metallic-soap-ceresin composition would not harden the composition. Magnesium palmitate, I understand from Prof. Holton's deposition, is also a metallic soap. I do not know whether it is harder than the soda aluminium stearate forming the foundation of the metallic-soap-ceresin composition of the patent in suit or not. If it is, I would confidently expect it to harden the composition. If it is not, then it would not. Gum balata, gun-cotton and ebonite are substances in regard to which I have expressed no opinion. Lead stearate, magnesium stearate, aluminium stearate, as well as stearate of soda, I understand to be metallic soaps, and whether or not they would harden the metallic-soap-ceresin composition of the patent in suit I should say would depend upon whether or not they are harder than the metallic-soap-ceresin composition. As to this, I am not informed. As to sand and saw-dust I should say that one who undertook to add these could be safely set down as an ignoramus in the art. As to plaster of Paris, gutta-percha, vulcanite, chromatized gelatin and rosin I have no information. I should, so far as my own information goes, certainly require experiment in order to determine the question. As to the action of shellac on the particular composition mentioned in the question, I cannot say, and the same is true of sealing wax and collodion. Lamp black has been used as a pigment in record compositions, and so far as my information goes does not affect the hardness of the material one way or another.

With the majority of substances mentioned in your question, experimentation would be necessary to enable me to determine whether they could or could not be successfully employed as a hardening agent in the metallic-soap-ceresin composition of the patent in suit, though whether experimentation would be necessary those more skilled in the practical art than myself, and more familiar with the materials mentioned, I cannot say.

*xQ*. 46. Two of the materials mentioned in your last answer are celluloid and shellac. If the desirable and undesirable properties of celluloid and shellac for the manufacture of molded records were well known, would it be, in your opinion, an obvious expedient to combine the two ingredients in order to produce a composition possessing the desirable properties of the separate ingredients, and reducing their defects? *A*. No.

*xQ.* 47. Why do you consider that the addition of shellac and celluloid would not be obvious while the suggestion of metallic soap and carnauba would be obvious?

*A.* Metallic soap and carnauba wax are analogous materials, that is, they are both wax-like materials. The effect of adding carnauba wax to other wax-like materials is well known in the art, whereas the effect of adding or mixing or compounding celluloid with either shellac or materials analogous to shellac is not, so far as I know, well known. In fact I do not know of anything in the arts which even disclose that shellac and celluloid can be combined into a record material, unless it be something of very recent date. Therefore, I say that it would require experimentation to determine whether or not celluloid and shellac could be combined so as to produce any specific or desired result.

*xQ.* 48. I direct your attention to patent to Herrington, No. 397,856 of Feb. 12, 1889, to patent to Herrington, No. 399,264 of March 12, 1899, and to patent to Edison, No. 713,209 of Nov. 11, 1902, and ask if these patents do not recognize both celluloid and shellac as wax-like materials in this art? *A.* No.

*xQ.* 49. Is it not a fact that of the several patents referred to in your direct-examination as disclosing recording materials, the only one which specifically refers to the molding of records is Edison patent No. 484,582, of Oct. 18, 1892?

*A.* I think that the only patent which I specifically mentioned in my direct deposition as a part of the art prior in date to that of the patent in suit is the Edison patent No. 484,582. This was not because there were not other patents which disclosed the art of molding sound records by pouring molten wax-like materials into a matrix, however. For example, Macdonald patent No. 682,991, of Sept. 17, 1901, granted on an application filed Nov. 8, 1900, clearly discloses such a record and he states that in carrying out his invention he fills the mold "with the melted material, (soap mixture or the like) which is hereinafter, for convenience, designated as 'wax,' though I do not limit myself to a wax-like composition, since any suitable material or composition that can be readily handled may be employed and will come within the scope of my invention."

Each of the claims of this patent are for a process of molding sound-records.

The prior art also includes two other patents to Macdonald, viz., Reissue patents No. 12,095 and 12,096, one of which relates to a process of molding sound-records and the other to the molded sound record itself. In patent No. 12095, express mention is made of the heating of the wax until it is "in a limpid state," and it is further stated that the superheating forces out all the air-bubbles and produces a concentration of the molten mass which with the subsequent contraction due to the sudden chilling, secures a "much denser and harder" surface than in the case of records theretofore made.

The only reason why reference is made to the Edison patent in my deposition in chief is because of the fact that it emphasized the idea of making a hard record by employing a wax-like material which was poured into molds or matrices formed by the electro-deposition of metal, and it was not by any means meant to be indicated that this was the sole illustration in the art, prior to the date of the patent in suit, of molded sound records.

*xQ.* 50. You were familiar, were you not, with the molded records first put out by defendant herein?

*A.* My first knowledge of molded records made by the American Graphophone Co. was during the time when they were using the mechanical duplicating process. By that process a record was employed as a master to direct the action of a cutting style in contact with a blank of wax-like material whereby a duplicate was cut in the blank corresponding in every particular with the original record. I had known for some time that one of the difficulties or objections lay in the fact that the master records employed for this purpose rapidly wore out when used in this mechanical duplicating process, so that only a limited number of duplicates could be cut from a single original before it was destroyed by wear. Upon the occasion of one of my visits to the factory I was shown by Mr. Macdonald certain mechanical duplicating machines in operation, and he told me that the masters which were employed on those machines (masters being the records which controlled the duplicating cutting styles) were not original cut records but were molded masters, made by electro-depositions of copper upon an original cut record to form a matrix into which matrix molten wax-like material was poured, thereby securing a large number of masters for the mechanical duplicating machines from a single original cut record.

I visited the part of the factory where the operation of making the matrices or molds was going on, and the records were being molded therein. I understand from Mr. Macdonald's answer to *xQ.* 39 that many of these masters were sold, and I presume they were the first molded duplicates put upon the market by the defendant company. With that understanding and to that extent I should say that I was familiar with the molded records first put out by defendant.

*xQ.* 51. Later on, molded records *as such* were sold by defendant that were the same as the molded masters to which you have referred, were they not?

*A.* Later on, molded records were sold by the defendants, but I cannot undertake to say that they were the same as the molded masters to which I have referred, since I was not always—nor even generally—cognizant of the exact dates when changes of this character were made.

*xQ.* 52. Do you, or do you not, recall that defendant's first molded records were made in an apparatus substantially identical with that disclosed in Macdonald Reissue patent No. 12,095?

*A.* I never saw an apparatus like that shown in this Macdonald reissue patent No. 12,095, and if defendant ever used such an apparatus in the factory in the commercial manufacture of duplicate sound-records, I never knew it. They did, however, practice the process set out in that patent.

*xQ.* 53. The first molded records made by defendant were cast around a spirally-threaded core, were they not, substantially as disclosed in this reissue patent?

*A.* My impression is that they were, though as to that my recollection is not entirely clear.

*xQ.* 54. It seems to have been Mr. Macdonald's idea, as disclosed in his two reissue patents Nos. 12,095 and 12,096, to secure hardness of the record by suddenly chilling the same, upon the theory that in doing so the stearic acid ingredient would be driven toward the outer surface. Is this your understanding of these patents?

*A.* It is not. In fact it is very nearly the reverse of this. The two ingredients of the composition which are mentioned in that patent are stearic acid and ceresin, and stearic acid is harder than ceresin, consequently has a higher melting point. From this it follows that if the mass were chilled the stearic acid would solidify in advance of the ceresin, since as the mass would cool down the solidifying degree, or the degree at which the stearic acid would become solid, would be reached before the degree at which the ceresin became solid. By applying the chilling action to the exterior, the stearic acid would be solidified before the ceresin and this would force or drive the ceresin toward the interior, leaving a film of the harder material—stearic acid—upon the exterior, giving a casting whose exterior surface is much harder and denser than the entire mass, though the graduation in hardness and density would gradually decrease from the exterior inward. From this it will be seen that the hardening of the stearic acid drives the ceresin inward, and not, as suggested in your question, that the stearic acid is driven outward. The effect, however, was that which I supposed you had in mind, viz., securing a hardened exterior with a softer interior by reason of the presence of the harder ingredient on the outer surface.

*xQ.* 55. Do you understand from these two Macdonald reissue patents that the composition specifically suggested therein is a mixture of stearic acid and ceresin, or a soap composition containing stearic acid and ceresin, or formed as the result of the saponification of stearic acid?

*A.* The patent does not specifically state that it is a soap mixture formed by the saponification of stearic acid, but it clearly would include a metallic soap composition with ceresin added, since in describing his material he designates it as "soap mixture or the like," and later on specifies stearic acid and ceresin as being present.

*xQ.* 56. But what, if any, information can you give the Court as to the meaning, or your understanding of the meaning, of the statement in each of these patents: "the composition at present employed (which is a mixture of two ingredients, as stearic acid and ceresin?"

*A.* The patent states that the mixture is one of two ingredients, as stearic acid and ceresin, as stated in your question, but that is not all the patent says about the material. The patent says that the material is a soap mixture or the like (lines 60, 61, page 1). Now, a metallic soap containing free stearic acid with ceresin as a tempering wax would be a soap mixture or the like, and it would be a mixture containing the two ingredients, stearic acid and ceresin, as quoted in your question. The statement in the patent is broad enough to include a metallic soap composition with free stearic acid and ceresin, such as mentioned in the Macdonald patent No. 606,725, as well as one consisting solely of stearic acid and ceresin.

*xQ.* 57. Then you think it would be a perfectly natural conclusion for an expert, reading the two Macdonald reissue patents, to conclude that one at least of the materials that the inventor contemplated using was a mixture of stearic acid and ceresin?

*A.* Yes, or one containing stearic acid and ceresin.

*xQ.* 58. By this answer do you mean yes, as well as a combination containing stearic acid and ceresin?

*A.* I mean, in the language of the patent in suit, that it contemplates the use of a material "comprising" stearic acid and ceresin, whether associated with other materials or not.

*xQ*. 59. If the composition of the two Macdonald reissue patents comprised a metallic soap, as well as stearic acid and ceresin, would you not conclude from these patents that Mr. Macdonald regarded stearic acid as a hardening ingredient?

*A*. In the illustration of a material which Mr. Macdonald gives when he mentions stearic acid and ceresin, he mentions two materials, one of which--the ceresin—is softer than the other—stearic acid—and in illustrating the working of the process points out how the congealing of the harder material by chilling from the exterior, drives the softer material toward the interior. Manifestly, if any harder material were present than the stearic acid it would in turn remain upon the exterior and drive the stearic acid and the ceresin toward the interior. Compared to ceresin, stearic acid is a hardening material and doubtless Mr. Macdonald, from his long experience in this art, was acquainted with that fact, just as Mr. Edison in his patent No. 400,648 referred to stearic acid as a hardening material in connection with beeswax and ceresin.

*xQ*. 60. Your idea is, then, that with these compositions while cooling commences from the outside and progresses inwardly, the ingredient having the lowest melting point tends to congeal first, gradually displacing the ingredients of higher melting point, so that the hardness of the record gradually and progressively decreases from the outer surface inwardly?

*A*. No, that is not my idea. And, moreover, I have not been undertaking to say what my ideas were, merely indicating what I thought to be the idea advanced by the Macdonald patent and this is not in accord with the statement in your question either. The ingredients in the composition having the highest melting point congeals first, according to the idea of the Macdonald patent in question, and drives the material having the lowest melting point towards the interior, so that the resulting record has a gradually decreasing hardness from the exterior inward.

*xQ*. 61. Do you accept that theory as correct?

*A*. I should not care to definitely pass on that question without a more careful and extended study thereof, but speaking off hand and without careful investigation I would say that it appears to me to be probably correct?

*xQ*. 62. Are you acquainted with the fact that when molded records were first put on the market by defendant as molded records, one of the claims advanced by defendant in commending those records to the public was that they could be shaved off and used as blanks which they stated in substance was not true of any other new molded record on the market?

*A.* No, I do not know whether they ever made any such claim or statement or not. I do know as a fact, however, that users of the American Graphophone Company's records were in the habit of either shaving them off or having them shaved off after they had been used a certain length of time and had begun to deteriorate, and used the shaved record as a blank upon which to make an original record by the action of the cutting style. In fact I have myself repeatedly done this.

*xQ.* 6. I understand you are not a chemist, Mr. Cameron?

*A.* No, what I do not know about chemistry would fill a large book.

*xQ.* 64. And you would not undertake to say, of your own knowledge, that if certain ingredients were added together under certain circumstances reactions would or would not take place?

*A.* I would not.

*xQ.* 65. Do your question the fact asserted in the patent in suit that when the carnauba wax is added at a high temperature the composition differs in physical properties from that obtained by adding the carnauba wax at a low temperature?

*A.* Of my own knowledge, I could not undertake to state that there was no chemical difference resulting from adding the wax at a high or low temperature. I do question the fact, however, unless it be such physical difference as results from the greater concentration of the wax-like material from prolonged high temperature. For example, it has been stated in Tainter patent No. 421,450 that boiling the wax-like composition would toughen it. As I understand it this would indicate a different physical condition. Moreover, I am informed by the deposition of a chemist of wide and extended experience, Prof. Holton, defendant's expert herein, that it is barely possible that there may be some slight chemical changes occur as the result of the high temperature, but that these are so small as to be negligible in the resulting mass as a whole.

*xQ.* 66. Does the Tainter patent, to which you refer in your last answer, go any further than to suggest that prolonged heating of ozocerite will tend to harden and toughen the same?

*A.* Yes, sir. It says that the ozocerite may be combined with other waxes, that it mixes readily with beeswax, carnauba wax and others, and that its use in such compositions is within the scope of the invention set out in the Tainter patent.

*xQ.* 67. Your understanding of the language of this Tainter patent is that it precisely and definitely describes the prolonged heating of ozocerite, combined with another ingredient or otther ingredients, rather than the addition of the latter to the ozocerite after it has been treated?

*A.* I understand that the patent contemplates the employment of the ozocerite alone or in combination with another wax or otther waxes, and that the treatment described by the patent for the record material is to be the same whether ozocerite alone is used or whether it is for the combination of waxes with ozocerite. My understanding therefore is that if ozocerite and carnauba wax were to be employed, they would be melted together and boiled with the resulting concentration and toughening of the composition.

*xQ.* 68. You do not consider the patent then as being in any way indefinite, but on the contrary you regard the patent as positively and definitely describing the treatment of the composition of ozocerite, and otther ingredients, after the latter have been melted together?

*A.* I consider the patent sufficiently clear and definite when in the hands of one skilled in the art to teach him that he could concentrate and toughen the composition of ozocerite and carnauba wax by boiling the same. Moreover, it is a common practice in the handling of commercial waxes, when it is desired to concentrate them, to boil them for this purpose.

*xQ.* 69. But is there a specific suggestion in the Tainter patent that when the ozocerite is added to something else the treatment is to be applied to the mixture or combination?

*A.* No, the specific statement in the patent is that in making the tablet, the wax surface is applied by melting the wax and applying it while in a fluid state, and that when the wax cools it contracts more than the paper foundation, causing it to crack away from the paper. It then states that "the use of the ozocerite wax, however, is not attended with this disadvantage." It proceeds then to state that it is advantageous to concentrate the crude wax by application of heat, and thereby render it more suitable for the purposes of the invention, and that "after concentration by boiling it becomes harder and tougher." In the same clause it gives direction for applying the wax to the paper foundation, saying:

> "It is then applied in a thin layer or coating to the foundation or other material, and on cooling is turned down until a perfectly smooth surface is obtained."

During this statement, no specific mention has been made of anything but ozocerite wax, but when the patent subsequently states that the ozocerite wax may be employed alone or in mixture with beeswax or carnauba wax, it is perfectly clear that the patent contemplates that the treatment of the mixture is to be the same as that prescribed for the treatment of the ozocerite. The patent does not specify any different way for applying the mixture to the paper or other material different from that described for applying the ozocerite. To the expert this clearly means that you are to handle the mixture in the same way as you would handle the ozocerite alone.

*xQ.* 70. The two suits referred to in answer to *Q.* 2 were the suits based on Edison patents No. 667,662 of Feb. 5, 1901 and No. 713,209 of Nov. 11, 1902, pending in the Circuit Court for the District of Connecticut, and decided in defendant's favor by His Honor, Judge Platt, are they not?

*A.* As I recall the numbers of the patents, I think that is correct.

*xQ.* 71. Assume that you had melted a quantity of rubber, and allowed the same to cool to 120 degrees C., resulting in the production of a viscid, sticky mass which you desired to make hard, and you knew that sulphur was a hard fusible substance. Now suppose you melted a quantity of sulphur and added the same to the sticy rubber mass at 120 degrees C., and found that on cooling the viscid nature of the material was substantially unchanged. Would it be obvious to you that on heating the mixture to a much higher temperature for a considerable period you might obtain a very hard and tough product?

*A.* With my absolute lack of knowledge in the art of treating rubber, the results supposed in your question would mean nothing to me.

*xQ.* 72. Suppose you take an oily, fatty acid, like oleic acid, and wish to harden the same, and you mix therewith carbonate of lead. At ordinary temperatures a white, sticky paste will result. Would it be obvious to you that by materially increasing the temperature a wax-like solid would be secured?

*A.* Being wholly ignorant of the chemistry of the materials mentioned, their acting in a certain way or failure to act in a certain way would not convey any idea to me as to what they would or would not do when treated under different or varying temperatures. What the conditions mentioned in your question would indicate to one skilled in the handling of such materials I could not say.

*xQ.* 73. You recognize, do you not, that in this art the expression "limpidity" is used synonomously with liquidity or the capacity to take sharp impressions?

*A.* I understand the expression limpid or limpidity has been used by great experts in this art, such as Mr. Macdonald and Mr. Edison, to mean liquidity or mobility, i. e., the characteristic when molten of becoming thoroughly fluid rather than viscous. But I do not understand that limpidity means the capacity to take sharp impressions? Of course the more freely fluid the molten material becomes, the more readily it comes into intimate contact with all parts of the mold, and to that extent limpidity would contribute to the securing of sharp impressions from the mold.

*xQ.* 74. Is it your idea that in these compositions the high degree of limpidity or fluidity which they possess is largely due to the ceresin or other hydrocarbon?

*A.* In Edison's patent No. 406,576 he states that asphalts vary in the degree of liquidity or mobility which is formed by melting them, and that some asphalts, even at a high temperature, form a thick semi-liquid which it is difficult to pour, and that he corrects this by adding to the asphalt a wax, such as ozocerite which is nothing but a crude form of ceresin. From this I understand that he obtains the required degree of liquidity or mobility as the result of the addition of ozocerite. The mixture which he uses is asphalt, carnauba wax and a softening material, such as ozocerite, from which it appears that the limpidity or liquidity of the composition is due to the presence of the crude ceresin (ozocerite) and that the presence of the carnauba wax does not interfere with this. I conclude from this that the presence of any considerable quantity of ceresin would tend to increase the limpidity of the composition. I would not, however, say that the limpidity is wholly due to this, since I understand that stearic acid, metallic soaps and even carnauba wax are more or less limpid when in a molten state or subjected to a high temperature. In answering your question then I should say that the ceresin contributes materially to the limpidity of the composition but that the limpidity is not alone due to this cause.

Cross-Examination closed.

Signature of witness and certificate of notary waived.

Counsel for defendant offers in evidence as defendant's exhibits, the following U. S. Letters-patent:

Bell & Tainter, No. 341,214; May 4, 1886;
Edison, No. 430,274, June 17, 1890;
Edison, No. 484,583, Oct. 18, 1892;
Edison, No. 484,582, Oct. 18, 1892;
Edison, No. 488,191, Dec. 20, 1892;

It is stipulated and agreed between counsel, subject to correction on reasonable notice, that the Thornberry record with carnauba, referred to in the deposition of Frederick A. Holton, was one of the identical exhibits produced by the witness Thornberry herein, and correspondingly identified in connection with his deposition.

## RE-DIRECT EXAMINATION.

*rdQ*. 75. In *xQ*. 34 and 35, complainant's counsel asks if you found in the prior art any specific reference to the use of carnauba wax with a metallic soap composition. Do you understand from the patent in suit, and from the patentee's (Mr. Aylsworth's) deposition herein, that there is any reaction between the saponified portion of the composition, i.e., the metallic soap proper and the carnauba wax, or any ingredient of the carnauba wax?

*A*. I do not. The patent in suit states that as the result of subjecting the mixture, after the carnauba wax has been added, to relatively high heat, a combination is effected between the alcohols of the carnauba wax and *the excessive stearic acid present* in the metallic soap composition. (Lines 94-98, page 2). By the expression "excessive stearic acid," I understand that reference is here made to free stearic acid, the same being free because there is more stearic acid in the composition than is necessary to satisfy the oxides present, and it was with this excessive or free stearic acid that the patent states that the alcohols of the carnauba wax will combine. This is confirmed by Mr. Aylsworth's answer to *xQ*. 49, in which he states that

> "What takes place is that part of the carnauba, the myricyl alcohol in a free state combines with a part of the excess of stearic acid."

This is in precise accord with the statement in the specification, and to my mind is conclusive as to the composition of the patent. Mr. Aylesworth, the patentee, in his deposition, states that there is no combination effected by the carnauba or any constituent thereof with the metallic soap of the composition, as distinguished from the free stearic acid of the composition.

No reaction is indicated either in the patent or Mr. Aylesworth's deposition, except the reaction between the *free* stearic acid and the alcohol of the carnauba wax, and Mr. Aylesworth's deposition makes it clear that it is the free alcohol of the carnuba wax that "combines with a part of the excess of stearic acid," as stated by Mr. Aylesworth in said deposition.

*rdQ*. 76. Do you find in the prior art any specific reference to the use with free stearic acid of any substance similar to carnauba wax, that is, similar in that it may contain a trace of free alcohol?

*A.* I do. In the Edison patent No. 400,648 of April 2, 1889, Edison states that he mixes stearic acid with any suitable wax, such as beeswax, and states that he prefers to use it in conjunction with ceresin (see the clause beginning at line 23). Now, I understand from the patent in suit, which mentions beeswax as to a greater or less degree being equivalent to carnauba for the uses mentioned in the patent, and also from the answer to *Q.* 8 of Prof. Holton's deposition which states that beeswax, according to the recent investigators, contains "a small quantity free myricyl alcohol," that for the purposes of the patent in suit beeswax may be regarded as an equivalent of the carnauba wax, and I therefore find that the Edison patent No. 400,648, referred to, clearly discloses the use of free stearic acid in the composition with the equivalent of carnauba, viz., beeswax.

I also find in U. S. patent to Miller No. 178,319, dated June 6, 1876, a clear description of a compound containing bar soap, which I understand from Prof. Holton's deposition, is a metallic soap (see answer to *xQ.* 66), stearic acid, paraffin, which is the equivalent of the ceresin employed in the patent in suit, beeswax, which is mentioned as one of the equivalents of the carnauba mentioned in the patent in suit, and lamp black. This substance is stirred "while being brought to boiling," and is then molded. Without being an expert from the chemical side, I understand that the boiling point of such a mixture of wax and soaps is very high, though whether it would go to 450 degrees to 475 degrees F. I am not personally informed.

*R-dQ.* 77. In *xQs.* 39-45, complainant's counsel asks you in effect whether it was obvious *a priori* that you could make a good cylinder composition and give it hardness by adding each of the enumerated list of hard substances. Please consider the list of substances named by complainant's counsel in *xQ.* 66 of Prof. Holton's deposition, and in *xQs.* 39-45 of your deposition; which of these, if any, would persons skilled in this art *know* beforehand could be employed for hardening the partially saponified composition of the Macdonald 1898 patent, without materially affecting the other desirable qualities of such a composition.

*A.* The one which he would know clearly and beyond all question could be employed for hardening the composition of the Macdonald 1898 patent would be carnauba wax, and that without materially affecting the other desirable properties of the composition.

*R-dQ.* 78. In *xQs.* 71-72 counsel for complainant asks you regarding the probable results of increasing the temperature upon certain specified compositions. Suppose you take the composition of the Macdonald 1898 patent, and add carnauba wax therto at a temperature less than 450 degrees F. and note that the resulting composition is eminently satisfactory for molding sound records and is harder than the same composition without carnauba; what would a person skilled in this art assume would result if the composition were subject to a higher temperature, say 450 degrees to 475 degrees F?

*A.* He would know that the resulting composition would be harder and tougher since carnauba wax is not broken up, or its constituent elements disassociated by a temperature of 450 degrees F. (see Mr. Aylsworth's answer to *x*Q. 49), and since previous experience had taught him that carnauba wax at the lower temperature produced a hardening effect, he would know from his previous experience that carnauba wax when subjected to a temperature that did not break it up or alter its composition, would produce the same effect, viz., a hardening effect. Moreover, he would know from the teachings of the Tainter patent No. 421,450 that the high temperature would concentrate the wax and cause it to become "harder and tougher," as set forth in that patent.

Counsel for defendant offers in evidence, as defendant's exhibit, the following U. S. Letters-patent:

No. 178,319, dated June 6, 1876, Miller.

Signature of witness and certificate of notary waived.

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WASHINGTON, D. C., Feb. 16, 1907.

Met pursuant to agreement.

Present—Mr. PHILIP MAURO for Defendant; Mr. FRANK L. DYER for Complainant.

And thereupon CHARLES E. MUNROE, a witness produced on behalf of defendant, being first duly sworn, deposes and says in answer to interrogatories propounded by Mr. MAURO:

*Q.* 1. Please state your name, age, residence and occupation?

*A.* My name is Charles E. Munroe; 57 years of age; my residence is Washington, D. C., and I am a chemist by occupation, being now the Professor of Chemistry at the George Washington University of Washington, D. C.

*Q.* 2. Please state briefly what experience you have had tending to qualify you as an expert witness in causes relating to inventions and discoveries, particularly such as involve questions of chemistry?

*A*. I was graduated as a bachelor of science in chemistry from Harvard University in 1871. I was appointed assistant in chemistry in Harvard University in 1871 and served in this capacity until 1874. From 1874 until 1886 I was Professor of Chemistry at the U. S. Naval Academy, Annapolis, Md. From 1886 until 1892 I was chemist to the U. S. Naval Torpedo Station and War College at Newport, R. I. From 1892 to the present time I have held the position of Professor of Chemistry in the George Washington University, though its name was until recently the Columbian University. Throughout the entire time from 1871 to date I have been engaged in the practice of chemistry as well as in the teaching of the same. I have repeatedly been employed as a chemical expert in issues before the Courts and particularly in patent causes. I have been employed as consulting expert both by private individuals and by the Government of the United States. I have for the Census of 1900 and for that of 1905 held the position under the Census Bureau of expert special agent in charge of the chemical industries of the United States, and as such have, either alone, or in conjunction with others, prepared sveral bulletins on the chemical industries or industries in which chemistry plays an important part. In the preparation of these bulletins I have resumed a very large number of patents, it being my endeavor in each art to resume every U. S. patent in the classes found in the Patent Office from the earliest patent granted up to 1900 or 1905, as the particular case may be.

*Q*. 3. Have you read and do you understand the specification of the Aylsworth patent in suit, No. 783,375?

*A*. I have read the patent and understand it.

*Q*. 4. Have you read and do you understand the prior patents of T. H. Macdonald, No. 606,725 and No. 626,709?

*A*. I have and do.

*Q*. 5. Assume that a person accustomed to working with a sound-record composition, such as described in the said Macdonald patents, wished to impart additional hardness thereto, without impairing its other useful properties, would or would not the common knowledge of the art as the same existed prior to the application for said Aylsworth patent (Nov. 3, 1903) enable him to do so without making any invention or discovery?

*A*. It would enable him to do so without making any invention or discovery.

*Q.* 6. Please state how the common knowledge of the art would instruct him to proceed in order to produce that result?

*A.* Having a wax-like body which it was desired to harden while retaining its other desirable properties, it was obvious that this might be done and could be done by mixing the wax-like body intimately with another wax-like body possessing the desired property to a marked degree, proportioning the mixture so that the average of the desired property furnished by the various components of the mixture would be that sought. The method by which such mixing is effected, and which would be followed in the manufacture of such a mixture, is that commonly practiced in this art, namely, by incorporating one of the components with the other components when in a fused condition, or semi-fused condition; i. e. the whole mixture would be raised to a temperature sufficient to permit of the complete and ready commingly of all the components. That is, the manufacturer or compounder of this mixture would melt the ingredients together in the proportions proper to secure the desired result.

*Q.* 7. Would it or not require any chemical knowledge on the part of the operator to carry out this operation properly?

*A.* It would not, because the operation is one of making a composition of matter through the mixing together of different substances which remain in the mixture of such and not in bringing about a chemical reaction through which new chemical substances are produced.

*Q.* 8. Can you, from your knowledge of the art to which the patents referred to relate, name any specific wax-like material or materials known prior to Nov. 3, 1903, to be suitable for admixture with a composition like that of the Macdonald patents for the purpose of imparting increased hardness thereto?

*A.* I can, and I do name carnauba wax as such a body which would add hardness to such a wax-like composition as that set forth in the Macdonald patents. In my examination of the United States patents for my census bulletins I have noted that carnauba wax was used in the plastic art in the manufacture of wax-like compositions of matter. Its use is old, and it has been employed in many compositions. I find, for instance, that as early as January 7, 1890, U. S. patent No. 418,947 was issued to A. Hart for a crayon composed of pigment and carnauba wax one pound, stearic acid one pound, and paraffin wax one and one-quarter pounds.

Nov. 20, 1888, U. S. patent No. 393,190 was issued to Charles

Sumner Tainter for a tablet for use in graphophones in which claim 1 was for:

> "1. As the recording medium for graphophonic records, a waxy composition containing carnauba-wax in admixture with other softer wax, substantially as described."

And Tainter states in the specification of this patent that carnauba wax is very hard and brittle, but mixes readily with beeswax and waxes of like nature and forms a compound eminently suited for the recording surface of a graphophonic tablet.

In patent No. 406,576 of July 9, 1889, issued to Thomas A. Edison for a phonogram blank, he says in his specification:

> "In making the phonogram blank I prefer to mix with the asphalt or bitumen a small percentage of a material which in solidifying shrinks or contracts greatly, such as certain waxes, and preferably carnauba wax."

These are a few of the instances in which carnauba wax has been previously used in wax-like compositions, and in which its properties and effects had been made known.

This use results from the marked hardness of the carnauba wax especially mentioned by Tainter. It is among all the waxes available in commerce that one which most notably possesses the property of hardness, and would therefore be the one which would most notably impart this property to compositions of matter of which it formed a portion.

*Q.* 9. Referring to the Aylesworth patent in suit No. 782,375. I call your attention to the statement, beginning line 94 of page 2 to the effect that by subjecting the mixture of metallic soap and carnauba wax to a relatively high heat a chemical reaction takes place "which gives to the composition many of its desirable characteristics." Please state whether or not the statements of the patent with respect to the alleged chemical reactions are correct, and kindly give your reasons for the opinion you may express?

*A.* I do not believe that when the carnauba wax and the metallic soap composition are heated as described any material chemical reaction occurs. My reason for this belief lies in the fact that the amount of alcohol in the free condition present in carnauba wax, if present at all, is present in but an inconsiderable quantity, occuring in the wax merely as a trace. And that, during such heating, there is no indication of any chemical reaction taking place. It is true that it is stated in lines 90-94:

> "When the carnauba wax is added to the soap mixture the temperature of the mass is raised to about 450 de-

> grees F. and maintained until all foaming cease. It usually takes about five hours."

And that, in certain chemical reactions, where gases are products of the reaction and where the reaction takes place in a body of liquid, there is effervescence, and if the liquid be viscous there is foaming. But I find that where carnauba wax is heated by itself so as to become molten and then the liquid wax is heated, effervescence takes plce with foaming, and this continues with heating for some time. I note as the material, the carnauba wax, begins to melt there is decrepitation which continues after the substance is melted. This decrepitation, meaning thereby a succession of mild reports, is evidently due to the escape of enclosed volatile matter, such as water and air which is driven off at the increased temperature. Also I note the escape of odoriferous vapors, indicating the volatilization of a portion of the carnauba wax itself, or of some of its components. The amount appears to be small, but in its escape in a gasous form through the viscous liquid it will produce, and does produce, foaming. I have tested this matter by adding the molten carnauba wax to molten stearic acid and have obtained an analogous phenomenon; i.e., foaming has been caused by the escape of the volatile portions of the molten materials. In my opinion the phenomenon is purely a physical one and not connected in any way with a chemical reaction.

*Q.* 10. Is there or not formed under the conditions stated in said Aylsworth patent a hard wax-like compound ether which gives to the composition many of its desirable properties?

*A.* In foaming compound ethers it is necessary to bring about a reaction between an alcohol and an organic acid. Such compound ethers occur already formed in the waxes, such as the carnauba wax. This is composed largely of the myricyl cerotate which is one of the compound ethers. In mixing the carnauba wax with the metalic soap composition, as is done by Aylsworth, this compound ether existing in the carnauba wax is introduced into the mixture. As I have already said, there may be in certain specimens of carnauba wax a trace of free myricyl alcohol, and this trace might form compound ether; but the quantity of it is insignificant in comparison with that introduced as already existing in the carnauba wax, and it would be insufficient in amount to materially affect the properties of the resulting composition of matter.

*Q.* 11. In what way, if at all, does the procedure described in the Aylsworth patent for mixing the carnauba wax with the metallic soap after the latter has been formed, differ from what you have described in answer to *Q.* 6 as the common method of making a mixture of several wax-like substances?

*A.* Aylsworth in effecting the mixing by melting the constituents has simply practiced that method of effecting the mixture of the wax-like bodies which has heretofore been employed in this art, and which method was well known at the time that his patent was applied for.

*Q.* 12. Assuming that the alleged invention of the Aylsworth patent consists in bringing about a chemical reaction between myricyl or like alcohols and the free stearic acid of the metallic soap composition thereby imparting to the resulting composition many of its desirable characteristics, would or would not that invention be employed by a person who melted carnauba wax with the Macdonald metallic soap composition of patent No. 606,725, with or without a pigment such as lamp-black?

*A.* In my opinion it would not for, as I previously said, when myricyl alcohol is present in carnauba wax it exists but as a trace and any product of its reaction would be so insignificant in amount as not to materially affect the properties of the body formed by the mixture of carnauba wax with the other materials of the Macdonald composition.

Cross-Examination waived.

Counsel for defendant offers in evidence as defendant's exhibits, copies of the following U. S. patents:

Edison, No. 200,521, February 19, 1878;
Berliner, No. 548,623, October 29, 1895;
Edison, No. 667,662, February 5, 1901;
Macdonald, No. 682,991, September 17, 1901.

Defendant rests.

Signature of witness and certificate of notary waived.

United States Circuit Court, District of New Jersey.

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|---|---|
| NEW JERSEY PATENT COMPANY<br>*vs.*<br>COLUMBIA PHONOGRAPH COMPANY, GENERAL. | In Equity No. 12,<br>On Letters Patent No. 782,375 |

## Complainant's Rebuttal Proofs.

(*Filed March 18, 1907.*)

Testimony in rebuttal for complainant, taken before HENRY D. OLIPHANT, a Standing Examiner of this Court at the office of FRANK L. DYER, ESQ., West Orange, N. J., commencing February 19th, 1907.

Present—FRANK L. DYER, ESQ., for Complainant, C. A. L. MASSIE, ESQ., for Defendant.

JONAS W. AYLSWORTH, a witness called on behalf of complainant, having been first duly sworn, deposes and says as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. You have already testified in this case, I believe?

*A.* Yes sir.

*Q.* 2. In your patent in suit from line 41 page 1, to line 5, page 2, you point out certain peculiarities which you state that a composition adapted particularly for making molded records should have. Regarding these alleged peculiarities, is it to be understood that at the date of your invention they were all new characteristics of a phonograph composition?

*A.* The statement in the patent of the peculiarities which an ideal molded record composition should possess was prepared by me and was embodied in the specification in almost my exact language. I sought there to point out the peculiar properties which should be possessed by the composition to fit it most perfectly for the molding process and to give to the resulting molded records desirable physical characteristics. The statement was prepared without any particular reference to the novelty of the individual peculiarities of the composition, because the composition is to be regarded as a complete accomplishment. It would be a very simple matter in this art to realize one, or perhaps a number of these ideal conditions; for instance, as to hardness, limpidity, and freedom from decomposition products, but the difficult problem was to produce a composition in which substantially *all* of the characteristics were realized in one and the same composition.

*Q.* 3. Have you read the depositions of Messrs. Macdonald and Thornberry, taken on behalf of defendant herein?

*A.* I have.

*Q.* 4. It seems to be the opinion of Messrs. Macdonald and Thornberry that with the exception of the fact that with your composition, or a composition embodying your invention, the material is somewhat harder than the blank composition used before your invention, all the other peculiarities or characteristics pointed out by you as defining an ideal molded record composition are realized in the use of the old blank composition. I will, therefore, take up *seriatum* the statements of the patent, in which these peculiarities of an ideal molded record composition are set forth, in order that the Court may have the benefit of your views thereon. The patent states (p. 1. lines 40-45) that:

> "In the first place the composition should be very limpid when in a molten or plastic state so as to flow into intimate engagement or contact with the record surface and thereby permit a very sharp impression to be received."

Messrs. Macdonald and Thornberry (in answer to *Q.* 22 and *Q.* 11 respectively) testify that in respect to limpidity, they perceived no difference between a composition employing no carnauba at all, and a composition employing "a substantial amount of carnauba wax." What, if anything, have you to say as to their views on this point?

*A.* I observe in the first place that both Mr. MacDonald and Mr. Thornberry attempted to compare the limpidity of the two compositions by a mere inspection or eye test. Limpidity is a molecular condition, and the eye test would be a very crude and uncertain way of making a comparison on this point, unless the variations were very discernible. Of course, one might observe by inspection that gasolene was more limpid than molasses, but it would be impossible to tell by the eye that gasolene, for example, was more limpid than water. It is of course evident that if we are dealing with a very viscous material, it will not take as sharp an impression of a fine record as a more limpid material: hence, the greater the limpidity the more perfect the impression will be that is received from the mold. When carnauba wax is molten, it is as thin and limpid as water, whereas, many of the other ingredients are more viscid. The addition of an appreciable percentage of such a very limpid material to the composition could have no other effect than to increase its limpidity. Not only would this follow as a necessary conclusion, but I have made tests to determine the comparative limpidity of the two compositions. In making these tests, I floated on the two compositions, maintained at the same temperatures, a metallic funnel having a small opening in the bottom and ascertained the time required for the funnel to fill and sink. I was surprised to see how very close the readings were in making these tests, and I determined that the composition employing carnauba was about 10% more limpid than the blank composition in which carnauba is not used.

*Q.* 5. The patent in suit (p. 1, lines 46-50) states:

> "It should be free of decomposition products, which would otherwise result in the generation of gas, forming bubbles, which would destroy the commercial character of the record surface."

Messrs. Macdonald and Thornberry state that this characteristic is true of the blank composition as well as of a molded record composition employing a substantial quantity of carnauba wax. Do you agree with them in this matter?

*A.* I agree with them. It is necessary that any composition from which records are made, whether by directly recording on a blank cylinder or by molding, should be free of decomposition products which might result in gas bubbles. This is even more true of a blank composition than of a molded record composition, because with a molded record composition gas bubbles might exist below the surface without doing harm, whereas, with a blank composition if bubbles existed below the surface, they might be disclosed during the shaving of the blank or during the formation of the record. This freedom from decomposition products is not a new characteristic of my improved composition. It is, and has been a desirable and necessary characteristic in a blank composition; but in making a satisfactory molded record composition the problem to be solved was to produce a composition in which this desirable property of the blank composition would be retained. In other words, viewing my improved composition as consisting of the old blank composition modified by the addition of a new ingredient added in a new way to produce new results, the problem was to so modify the blank composition that while obtaining new results necessary in the molded record art, I should still retain the desirable characteristics which the blank composition itself possesses.

*Q.* 6. The patent in suit p. 1, lines 50-52) states:

> "It should be of excessively fine texture or grain, so as not to produce extraneous sounds when the reproducer rubs over it."

On this point, Messrs. Macdonald and Thornberry testify that from their observations, there is no difference between the blank composition and a composition employing a substantial amount of carnauba wax, as described in the patent in suit. Do you agree with them?

*A.* I do. I do not claim that the smoothness of record surface is a new characteristic of my improved composition. It was not necessary to improve the record surface, because the surface of the ordinary blank composition is very smooth. The problem was to produce a composition which, while it should have the desirable properties necessary in the molded record art, should retain the smooth surface of the blank composition. Many ingredients might be used which would add hardness to the composition and make the resulting records more durable, but it was a difficult matter to strike the exact composition that should have *all* the additional properties that are important in the molded record art, while still retaining the desirable properties that were known in the manufacture of compositions for phonograph blanks. Mr. Edison has given a good deal of thought to molded record compositions, and before my invention, suggested the possibility of using as ingredients for hardening materials, relatively gritty substances like chalk or fine precipitates. While the addition of these materials would harden the composition, they would make the surface rough.

*Q.* 7. The patent in suit (p. 1, lines 52–55) states:

> "It should be very hard when set, so as to reduce wear as much as possible, due to the tracking of the reproducer."

Messrs. Macdonald and Thornberry both admit that when even a relatively small percentage of carnauba wax is used, the wearing qualities of the records are very perceptibly increased. I suppose you agree with them on this point?

*A.* Yes, I do. Mr. Macdonald, however, is not, I think quite right in his explanation of the cause for the increased durability. As I understand his testimony, he believes that when carnauba wax is introduced at a high temperature it merely makes the composition harder and therefore more durable. My experiments have shown me that durability of the record surface is due more to the *toughness* of the material rather than to its hardness. I found that when the carnauba is added at a low temperature it makes the composition considerably harder than when added at a high temperature. This is stated in the patent page 2, lines 101–107. When the carnauba is added at a high temperature, chemical reactions take place, which toughen the composition and increase its durability.

*Q.* 8. The patent (p. 1, lines 55–69) states:

> "It should have the capacity of passing from the liquid to the solid state through an intermediate condition of gradually-reduced plasticity, to thereby enable the duplicate to shrink internally and toward the surface, so as not to clear the mold until quite hard, to thereby preserve the record, instead of chilling very rapidly at the surface to form a relatively hard film, which tends to shrink away from the mold even when the mass of the material is still molten, since I find that materials having this latter characteristic are not suitable for the purpose, owing to the danger of the record-surface being injured under the effect of the unequal chilling."

Messrs. Macdonald and Thornberry as to this point, state that they observed no difference between the composition employing a very substantial amount of carnauba and the ordinary blank composition. Do you agree with them?

*A.* Yes. I think they are correct. The particular phenomena which takes place during the setting and contraction of my improved composition, except possibly in degree, are those which attend the setting and contraction of the blank composition.

*Q.* 9. Are you familiar with the art of making phonograph blanks as well as the art of making molded records?

*A.* Yes. I have been in close touch with both arts since their inception. Phonograph blanks, exactly as they are now made, have been so manufactured for more than ten years and their composition has been used since 1888 or 1889. I have frequently witnessed the manufacture of phonograph blanks, and have been often consulted as an expert where difficulties have been met with.

*Q.* 10. Having reference to these phenomena attending the setting and shrinkage of your improved composition, as well as the prior blank composition, are they of equal importance in the two arts, namely, in the manufacture of molded records and in the manufacture of phonograph blanks?

*A.* No, I do not consider that they are of equal importance. In the manufacture of molded records, it is absolutely necessary that the material should set and become hard while in contact with the mold, so that the record will retain its form in the minutest detail and that *then* the material should shrink away from the mold, so as to permit the removal of the record. But, in the manufacture of blanks it is quite unimportant whether the material shrinks away from the mold or not, before it is entirely hard, because in the manufacture of blanks it is always the practice to shave them off before they are used. As a matter of fact, in blank manufacture, the blanks are forcibly pulled out of the molds while they are hot and still sticky and a very rough surface results. The difference between the molded record art and the blank art is that with the former the surface must be entirely finished while in the mold, whereas, with the latter, the surface is always finished by shaving after removal from the mold. Therefore, these phenomena regarding setting and shrinking are absolutely necessary in the molded record art, whereas so far as the blank art is concerned, the ideal composition would be one which, after it had set, would shrink away from the mold while its surface was still more or less soft and plastic, in order that the operations might be performed with greater rapidity. In other words, in the blank art, the particular phenomena under consideration make it necessary to forcibly remove the blank from the mold in order to save time in manufacture.

*Q.* 11. Do you agree with Messrs. Macdonald and Thornberry that the two compositions are the same in respect to the statement in the patent in suit (p. 1, lines 69-71) that:

> "It should not be sticky or tenacious so as to adhere to the mold when set, even to the smallest extent."

*A.* No, I do not agree with them. In this respect the peculiar property of the carnauba composition is that it stays in contact with the mold for a considerable longer time than the blank composition, so that when the material leaves the mold, its temperature is considerably lower than is the case with the blank composition. Since its temperature is lower, the record surface is harder, so that there is less danger of the material sticking to the mold than with the blank composition. Furthermore, since the carnauba composition is perceptibly tougher than the blank composition, it is enabled to detach itself freely from the mold with lass danger of any part of the surface being torn off. I have made many thousand experiments with the blank composition and with the carnauba composition and I have satisfied myself that in this respect the carnauba composition is decidedly superior to the blank composition. Of course, it is possible by exericsing great care to obtain reasonably satisfactory results with the blank composition, so far as this particular point is concerned, but under the conditions of commercial manufacture the percentage of discards with the blank composition due to sticking to the molds would be considerably greater than with the carnauba composition operated under the same conditions.

*Q.* 12. Have you made any experiments recently with the blank composition and with the carnauba composition to determine the correctness of the view expressed in your last answer?

*A.* I have. I had made under my direct supervision and observation about one hundred records from each of several compositions, including the ordinary blank composition and that of the patent in suit, as well as a composition employing the percentage of carnauba wax used by defendant, and also the patented composition foamed off at a low temperature so as to avoid chemical reaction. All of these records were made under exactly the same conditions of operation and temperature as nearly as it was possible to observe.

*Q.* 13. Please refer now to the point referred to in *Q.* 11, in reference to the relative stickiness or tenacity of the patented composition as compared to the ordinary blank composition and state whether your experiments indicated any superiority of the patented composition in this respect?

*A.* They did show the superiority of the patented composition in this respect over the blank composition. All of the records molded from the blank composition had a more or less dull surface which was especially noticeable on the thick end of the record, which is the end which shrinks loose from the mold first, as a rule. It was necessary for the records to be burnished with cotton a great deal longer to make them of a uniform glossy appearance than is necessary with the patented composition, which in most cases requires no burnishing at all, but the record is completed in the mold with a smooth and brilliant surface. The effect of this dull surface makes the reproduction sound somewhat rougher and less perfect than it does with the patented composition. This fogginess of the record made of the blank composition results in leaving the mold dirty, since a small part of the record surface is left on the mold, which necessitates more frequent cleaning than when the patented composition is used.

*Q.* 14. In the present development of the molded record art, would you consider a composition to be successful that resulted in the presence of a more or less foggy surface on the records and necessitated frequent cleaning of the molds, to which you have just referred?

*A.* I would not. Of course, it might be possible by frequent cleaning of the molds to minimize the effect and by burnishing the molded records to make them so that the fogginess would not be noticed so far as the eye is concerned, yet, those records which had such defects would not be perfect as compared with those made with the patented composition, so far as reproduction to the ear is concerned.

*Q.* 15. Are you able to state whether this cloudy appearance due to the sticking of the blank composition to the mold in manufacture was developed only on a small percentage of the records, or on a considerable part of them?

*A.* It was developed on nearly all of them, or in fact as far as I observed, on all of them. I did not pick up each record and examine it in this respect, but in looking over them as they stood on the trays, they all seemed to have the foggy effect.

*Q.* 16. And was this foggy effect present on the records made of the patented composition?

*A.* Only in a very few instances.

*Q.* 17. Was it present in the composition made in which the same percentage of carnauba was used as defendant employs?

*A.* Not in any greater degree than the patented composition.

*Q.* 18. And what about the composition where carnauba was used in an uncombined state?

*A.* I do not remember of noticing the effect in particular in this composition. This effect when it occurs on a dark composition like that of the patent, is very much more conspicuous than it is on a lighter colored composition like the blank composition or the composition containing carnauba, which was not heated to a high temperature. The effect to be noticeable at all in a light composition must be relatively great, and in the case of the blank composition it was very apparent and was difficult to remove even when the burnishing was carried to the extent of injuring the surface.

*Q.* 19. The patent (p. 1, lines 71-74) states:

> "It should be capable of shrinking away from the mold when quite hard by a reduction in its temperature."

Messrs. Macdonald and Thornberry state that so far as they could determine by an eye test, there was no difference in this respect between the carnauba composition of your patent and the blank composition. Do you agree with them?

*A.* Substantially yes, although as I have just pointed out, with the blank composition the material leaves the mold when the record is at a higher temperature that with the patented composition, so that there is always danger of the material adhering to the mold and producing a foggy surface. If the expression "quite hard" means that the composition should be hard enough as to overcome this difficulty, then I would not agree with Messrs. Macdonald and Thornberry that the two compositions are the same, because as I have pointed out, one results in records having foggy or cloudy surfaces, or in which such surfaces are likely to occur, and the other does not.

*Q.* 20. The patent states (p. 1, lines 74-76) that:

> "It should have a very smooth and polished surface so as to eliminate foreign noises, due to the tracking of the reproducer."

As a result of your experiments, did you observe any difference in this respect between the patented composition and the blank composition?

*A.* There was a difference, as I have already said. With the records made of the patented composition, the surface upon leaving the mold was highly polished and brilliant, whereas, with the blank composition, the surface was more or less cloudy and foggy, and required burnishing to give the polished effect. If the attempt is made to use the latter records without burnishing them, they would be very rough. The burnishing merely improves the appearance to the eye, but the reproduction is still objectionable and full of foreign noises.

*Q.* 21. The patent (p. 1, lines 77-80) states:

> "It should be free from air and gas bubbles, which if present at the surface would destroy the commercial character of any duplicates containing them."

Do you agree with Messrs. Macdonald and Thornberry as to the substantial identiy of the two compositions, so far as this characteristic is concerned?

*A.* Yes, each composition was equally free of gas bubbles and products of decomposition.

*Q.* 22. The patent in suit (p. 1, lines 80-82) states:

> "It should shrink uniformly without warping, so as to be capable of effective use with standard talking-machines."

Do you agree with Messrs. Macdonald and Thornberry as to the identity of the two compositions in respect to this characteristic?

*A.* No, from the blank composition a great many records had to be discarded on account of warping, which made the records out of round and unsuitable for use on the phonograph. The presence of carnauba wax in the composition has the very valuable property of producing substantially uniform shrinkage and of materially reducing any tendency to warping.

*Q.* 23. Is this property of the patented composition of equal importance in the two arts of making molded records and making phonograph blanks?

*A.* No, it is not. In making phonograph blanks, the blanks are allowed to season for a time before they are finished either on the inside or the outside, so that it becomes possible to make them perfectly concentric and they can be thus fitted for use with the phonograph. But with molded records, they cannot be thus seasoned, and finally finished, but have to be completely finished while in the mold, so that no further operations can be performed on them in the way of trueing them up or making them concentric. A molded record must have the capacity of shrinking uniformly, which is not important in the manufacture of blanks, nor is it realized in the blank composition. The experiments which I have made show that the blank composition shrinks irregularly and a large percentage of the records had to be discarded because they are not sufficiently concentric for use.

*Q.* 24. Are you familiar with the molded records that were first manufactured and sold by defendants as molded records shortly after the Edison records were first put on the market?

*A.* I saw a number of these records shortly after the Edison records were put on the market which were marked "Columbia" records.

*Q.* 25. I show you a record and ask if you can identify it as one of the early Columbia molded records?

*A.* Yes, that is exactly the appearance of the records that I saw, to which I have referred.

*Q.* 26. Can you tell from the appearance of that record whether it was finished completely in the mold?

*A.* This record has not been finished completely in the mold. It has been cut or reamed after the material was cold, which is seen by the smooth burnished surface on the top of the ribs on the interior of the record. The record appears to be somewhat oval, as is seen by the ribs being more completely cut away on one side than on the opposite side. This effect is very characteristic of the blank composition and was experienced in the experiments which I made. It, however, was overcome in a measure by placing them on cores before they had entirely cooled, but even with this precaution the effects were still noticed in the results.

> The record referred to by the witness is offered in evidence and marked "Complainant's Exhibit Early Columbia Molded Record."
>
> It is admitted by Counsel for defendant that the exhibit just introduced is one of the first type of molded records that were put out by defendant and sold as such on or about March 1, 1902.

*Q.* 27. Are you familiar with the fact that after the defendant had been marketing molded records similar to the exhibit you have just introduced, for a year or more, it changed the character of its product by doing away with the spiral rib on the interior and using concentric ribs and by making the records much darker than before?

*A.* I am. I noticed a number of Columbia records in which these changes were made that are referred to in the question.

*Q.* 28. I show you a molded record and ask if you can identify it.

*A.* I recognize this as one of the defendant's records of the same type that they are now marketing, except as to the label. When they first put out these records, the records were not labeled as at present.

> The exhibit referred to by the witness is offered in evidence and marked "Complainant's Exhibit, Present Columbia Record."

*Q.* 29. Does this record indicate any superiority as to uniformity of shrinkage from the first record considered?

*A.* Yes, this record is much more perfect in that respect, but this would be expected, since I infer that it is made of the same composition that the defendant now uses, employing carnauba.

> It is admitted by counsel for defendant that the record last referred to by the witness is identical with the records marketed by defendant, after the change in its present composition.

*Q.* 30. Referring again to the patent in suit, it states (p. 1, lines 83-86) that:

> "It should not be affected by moisture, so as to be preserved in damp climates, and it should have a high melting-point, so as not to soften in hot localities."

Messrs. Macdonald and Thornberry have expressed the view that as to this point the carnauba composition of the patent is identical with the blank composition. Is this so?

*A.* Not entirely. As regards being affected by moist air in a hot damp climate so as to roughen the surface, the composition containing carnauba is rather superior to the blank composition. Tests which we have repeatedly made to determine this point have always shown the carnauba composition to be superior to the blank composition. Records were put in a box which was maintained at a uniform temperature of 120° F. and in the box was placed a vessel containing water which saturated the atmosphere in the box. Then the time it took to develop a roughness on the surface was noted. The difference as I remembr it was very marked under these conditions. Furthermore, when we were making the mechanically duplicated records on the blank composition, many complaints came in from various parts of the country and many records were returned owing to the surface becoming damaged by moisture and mildew, the mildew effect being such as is produced on leather in damp dark cellars. Although there have been many million records made of the patented composition, I do not recall a single instance of this mildew effect taking place or of any records being returned on account of this defect.

*Q.* 31. To what do you attribute the superiority of the carnauba composition in this respect?

*A.* Probably to some antiseptic quality which is imparted to the composition by reason of the carnauba or possibly the lamp black.

*Q.*32. Referring again, to the fact that the composition should not be affected by moisture, what ingredient in the composition is relied upon to produce this effect?

*A.* The hydrocarbon ingredient (i. e. the ceresin) and the carnauba wax ingredient.

*Q.* 33. When carnauba wax is used, is it possible to employ a smaller percentage of the hydrocarbon ingredient to get the same anti-hygroscopic effect?

*A.* It is, but the records become rather more brittle so that it is necessary to add sufficient quantity of the hydrocarbon material not only to assist in the prevention of the moisture effect, but also to soften or temper the composition.

*Q.* 34. The patent states (p. 1, lines 86-90) that:

> "When hot, it should be capable of being cleanly cut in reaming without dragging or chipping, so as to present a smooth clean surface on the bore of the duplicate.

Do you agree with Messrs. Macdonald and Thornberry that in this respect, the carnauba composition is the same as the blank composition? *A.* Yes, essentially the same.

*Q.* 35. Is this quality of the same importance in the molded record art as in the blank art?

*A.* It is of no importance in the blank art, because in the manufacture of phonograph blanks, the latter are all reamed out on their interior after the material is seasoned and is entirely cold. Therefore, it is immaterial in the blank art whether the material cuts smoothly while hot, or not. In the manufacture of molded records, however, it is highly important that the material should cut smoothly while hot, because they have to be finished or substantially finished while still in the mold, and they stay in the mold only when they are in a heated condition. This peculiarity illustrates one of the problems met in making a successful molded record composition. It was necessary to make a composition which, while having the new properties necessary for the molded record art, should still retain the desirable property possessed by the blank composition, but not utilized in the blank art.

*Q.* 36. The patent (p. 1, lines 90–92) says:

> "Preferably it should be of a very dark color to permit imperfections to be better observed."

What is the practical commercial value of this feature in the molded record art?

*A.* It enables the imperfections of molding to be more readily discovered, and that by simple eye tests, than is the case where records are of light color. It furthermore gives them a uniformity which is commercially desirable, since the trade prefers a uniform dark colored record. They might get a dark record one time and a very light on another time, if the composition were not made uniformly dark. As it is not possible to make them uniformly light without great waste of material, due to the discarding for scrap, the way to obviate this difficulty is to make them uniformly dark, which, as stated, possesses the additional advantage of permitting them to be more perfectly inspected.

*Q.* 37. Finally, the patent (p. 1, line 92, p. 2, line 105) states:

> "It should be perfectly amorphous and non-crystalline, since the latter materials harden very quickly at the surface when their congealing temperature is reached and shrink irregularly, with the objections pointed out."

Do you agree with Messrs. Macdonald and Thornberry that as to this feature, the patented carnauba composition is the same as the blank composition?

*A.* Essentially the same. But, here again, the problem was to produce a molded record composition which, while possessing the new features necessary in that art, should retain the desirable properties of the old material.

*Q.* 38. The position of defendant in this case seems to be that the composition of your patent consists simply in taking the old blank composition and adding carnauba wax to it for the purpose of hardening the mixture, and that since carnauba was a known ingredient in connection with waxes such as ozokerite and bees' wax for the manufacture of record materials, no invention would be required on your part to produce the patented composition. Do you agree with this conclusion? In answering you might explain the direction of your experiments and investigations which led to the production of the patented composition.

*A.* When I started experimenting on making molded records over five years ago, I first attempted to make the records of the blank composition, but these attempts were not successful at that time. It was apparent that the molded record composition should be considerably harder and more durable than the blank composition, and also, that we would have to pay no attention to the property of the blank composition so far as its peculiar fitness for receiving the record impression by cutting was concerned. The duplicate records as formerly made by mechanical means, were limited to a material which could be readily cut, and consequently, such records were more easily worn on reproduction than are the records as made today from the patented composition. My experiments were then directed toward producing a harder and more durable material and which at the same time would not have the objections which I encountered with the blank composition in attempting to mold it. I recall that the composition which we called "hard regular" was tried, that is, the blank composition omitting the ceresin, which is very much harder than the blank composition with ceresin, but this material could not be satisfactorily molded as it was very irregular in shrinkage, and shrunk loose from the mold before the record could be finished. Various materials were then mixed with the "hard regular" to try and overcome this difficulty in the matter of shrinkage without much success being attained. Among the materials experimented with, were asphalt, various varnish gums, rosin, shellac, carnauba wax and Florida clay mixed with the "hard regular," with and without ceresin, but none of these materials at first produced satisfactory results. In many cases, they did not satisfactorily mix with the hard regular wax, and in other cases where they did mix, the shrinkage and molding properties were not favorable. I remember to have used carnauba wax in these experiments but it was not until the composition was made employing carnauba and in which the temperature had been raised to a very high degree that a successful result was obtained. I realize that in the refinements of the art as practiced to-day, many compositions can perhaps be successfully molded, but at that time the one composition that stood out alone as being the only one which we could consider sufficiently perfect to go ahead with in manufacture was the composition of the patent in suit. During this work I made several hundred experiments trying all sorts of combinations and was engaged several months in the search, the result of which was that my investigations were narrowed down to the composition of the patent in suit. That was the only composition that seemed to meet all the desirable peculiarities necessary in the new art, both as to its molding properties and as to its properties in the final records themselves. As to the position of defendants, I can only say that the composition of the patent in suit, or the possibility of using carnauba wax in connection with a metallic soap mixture, was not obvious to me. I had no way of knowing that carnauba wax would properly mix with the metallic soap composition. I could not tell whether the carnauba would add desirable properties to the metallic soap composition without destroying its good properties already possessed by it. As a matter of fact, I had been perfectly familiar with the properties of carnauba for more than ten years, and if I would have taken anything for granted it would be that carnauba was quite unsuitable for the purpose. The making of the patented composition was effected only after many experiments were made.

*Q.* 39. The position of defendant seems to be that anyone seeking to make a hard composition or to harden a known composition would naturally turn to carnauba wax as the proper ingredient to be used. In the companion suits, Numbers 10 and 11, based on the Macdonald patents, your note books have been introduced, illustrating your work in connection with the production of phonograph compositions from 1888 to 1895. Kindly refer to these note books and state what materials you were familiar with as a result of those experiments that you might have used is the only problem to be solved was the hardening of the blank composition?

*A.* In the experiments referred to, I had occasion to test practically all known materials, many thousand in number, which might be used in the art, and among the materials with which I was familiar at the date of the experiments, which resulted in the patented composition and which might have been used as hardening ingredients, are the following:

Shellac,
Myrtle wax,
Naphtholine,
Carnauba wax,
Asphaltum,
Kauri gum,
Gum Dammar,
Syrian asphalt,
Hard Mexican asphalt,
Sulphur,
Ceresin residue,
Paraffin residue,
Lead palmitate,
Lead stearate,
Iron stearate,
Kaolin,
Aluminum stearate.

*Q.* 40. Would any of these hardening ingredients except carnauba be suitable for use in the molded record art?

*A.* Not as practiced to-day; what the future may bring forth I do not know.

*Q.* 41. Then of this list of hardening ingredients, the only one that possesses all of the properties necessary for making a successful molded record composition is carnauba wax?

*A.* That is correct. The recollection of my early experience with molding compositions was that carnauba wax, in fact, was not very favorable, and it was quite by accident that the carnauba composition was tried at all. I remembered that it was difficult to mold even a blank from compositions which contained much carnauba as it had such a shrinking effect as to make it very difficult to cast the blanks successfully. Knowing this effect of shrinkage which carnauba possessed, it was not considered by me a very promising experiment when I first tried it, and I recall that carnauba was used in a number of experiments which were not very successful. This I attribute to the fact that with these experiments the materials were probably not heated sufficiently to produce the reactions. In making preliminary experiments of this kind, I seldom used the thermometer, excepting when making up a large amount, but I usually judged the temperature more by the eye than by the thermometer and could easily have made compositions with carnauba and not heated them a sufficient time to produce the reactions, and consequently in that way may have lost its valuable properties.

*Q.* 42. On that very point, the position of defendant seems to be that since the composition is foamed off with the carnauba at the same temperature that was maintained before the carnauba was added, the obvious thing for any one to do would be to keep up the temperature during the addition of carnauba. What, if anything, can you say on this point, as a result of your experiments?

*A.* I do not consider that it would be obvious to keep up the temperature to the point at which the original blank composition was foamed off, because as a matter of fact in making experiments in which the blank composition is used, some regular stock blank composition is usually melted and requires no foaming off, and if mixtures are to be made they may be made as soon as the wax is melted sufficiently for them to mix. On the contrary, the average experimenter would be careful not to overheat such a mixture, especially if he saw that if he did a reaction was going on which might convey to him the impression that the materials were decomposing. And these reactions do go on for a considerable period of time, generally from one to five hours, and unless a person knew in advance that these reactions were going to produce some change in the material that would be favorabie, he would, I believe not use a high temperature, and if he did use a high temperature, and observed that decomposition was taking place, I believe he would reduce the heat or possibly start over again under the belief that he had spoiled the experiment. As a matter of fact, although I have made a great number of experiments in this art, the expedient of heating the composition to a high temperature and maintaining it at a high temperature until all reactions had ceased, was the result of an accident, due to the fact that I left a batch of the composition in a heated condition and during my absence the temperature increased so that when I returned the reactions had taken place. When I examined this accidently-made composition, I found that I had discovered the exact material that I had been looking for.

*Q.* 43. Please examine the patents which have been granted in this art, and point out the materials mentioned therein as suitable for the manufacture of phonograph records, indicating specifically any materials or combination of materials that may have been suggested prior to your patent for the manufacture of molded records?

*A.* I have examined the several patents granted in this art up to the date of the application for the patent in suit, and find that they disclose the following ingredients or compositions for use in the manufacture of phonograph record tablets:

Tinfoil and paper are referred to in Edison patent No. 200,251 of February 19th, 1878;

Steel and other metals referred to in patent to Reynolds, No. 287,166 of October 23, 1883;

A mixture of bees' wax and paraffine is referred to in the patent to Bell & Tainter, No. 341,214 of May 4th, 1886;

Iron is referred to in the patent to Tainter, No. 341,287 of May 4th, 1886;

Paper parchment and metal are referred to in patent to Berliner No. 372,786 of November 8th, 1887;

Boiled tar, pitch, resin, asphalt and dental wax are referred to in the patent to Herrington, No. 392,953 of November 13th, 1888;

A mixture of carnauba and bees' wax or ceresin wax, of paraffine, or bay-wax is referred to in patent to Tainter No. 393,190 of November 20, 1888;

Metallic soaps are referred to in patent to Edison No. 393,968 of December 4th, 1888;

Celluloid, glue, wax, molasses, pitch and asphalt, or two or more of such materials in combination, and particularly a mixture of celluloid, molasses and bees' wax are referred to in patent to Herrington No. 397,856 of February 12th, 1889;

Wax, resin, pitch, celluloid, glue and rubber are referred to in patents to Herrington, No. 399,264 of March 12th, 1889, and No. 399,265 of March 12th, 1889;

A mixture of stearic acid and ceresin is referred to in patent to Edison No. 400,648 of April 2d, 1889. In this patent the stearic acid is referred to as a "desirable hardening material."

Metallic soaps are referred to in patent to Edison No. 400,649 of April 2d, 1889. The patent also refers to the use of a wax or a combination of waxes.

A mixture of oleate of lead and palmitate of magnesium is referred to in patent to Edison No. 400,650 of April 2d, 1889.

A hard metallic soap is referred to in patent to Edison No. 406,570 of July 9th, 1889;

Hard metallic soaps are referred to in patent to Edison No. 406,571 of July 9th, 1889. This patent states that the surface may be softened by applying to the same a weak alkaline solution or even moistening the same with water. I recall the experiments mentioned in this patent very well, the idea being to make it possible to remove a continuous shaving. The special surface treatment seemed to make the material slightly cohesive, but it did not toughen it in the sense that I use the word in my patent, *i. e.*, having the capacity to resist wear. The patent also refers to the production of "tough films upon the surface of the blanks" by applying to the same gum balata dissolved in bisulfid of carbon, or gun cotton dissolved in amyl acetate, or glue, dissolved in water;

Stearate of soda as a suitable material for the surface coating of a composite blank is disclosed in Edison patent No. 406,576 of July 9th, 1889. The patent describes an inner or body layer formed of natural asphalts, asphalt pitch and hard coal tar pitch. To permit the latter to shrink out of the molds into which it is poured, the patent suggests the addition of 5 to 6 per cent. of carnauba wax, that is referred to as a material which in cooling shrinks or contracts greatly. Finally, the patent suggests that in order that the asphalt may be made limpid enough so as to pour readily into the molds, it may be admixed with a small quantity of Japan wax or ozokerite or with crude petroleum, turpentine, melted rosin, or tar;

A composition of stearate of soda and oleate of alumina for the outer or surface coating of a phonograph blank, and an inner or body coating of hard rubber or ebonite. are desclosed in patent to Edison No. 414,759 of November 12th, 1889;

Ozokerite is referred to as the outer or surface coating of a composite record in the patent to Tainter No. 421,450 of February 18th, 1890, the inner layer or support being a paper tube. The patentee suggests the possibility of mixing the ozokerite with "bees' wax, carnauba wax and others." It further says:

> "In forming a tablet with ozokerite wax it is advantageous to concentrate the crude wax by the application of heat until it loses from ten to thirty per cent. of its weight, which renders it much more suitable for the purposes of the invention. After concentration by boiling it becomes harder and tougher, changing in color from a brownish black to a deep black. It is then applied in a thin layer or coating to the foundation of paper or other material, and on cooling is turned down until a perfectly smooth surface is obtained.
>
> In heating the ozokerite wax a high temperature is necessary, in order to produce the concentration desired. At 250° Fahrenheit the vaporization proceeds very slowly, and it is customary to employ a temperature of 400° Fahrenheit and upward. The duration of the treatment will, of course, depend on the temperature employed."

As is well known, ozokerite is impure or unrefined ceresin. This is always contaminated with a considerable proportion of volatile constituents, which make it soft and under the effect of heat, these volatile constituents are driven off, so that the material more closely resembles ceresin. Ceresin is harder and tougher than ozokerite, even when the latter is concentrated as described in this patent. Continued heating of ceresin does not increase its toughness, because there are no more volatile constituents to be driven off, but such treatment actually makes the material softer, since it tends to split up the hydrocarbons of which it is formed.

Metallic oleates and stearates, such as oleates and stearates of lead, magnesium and aluminum, are described in Edison patent No. 430,274 of June 17th, 1890. The patent states that these metallic soaps "may be employed alone, or mixed with other materials, such as waxes, resins, or gums."

Plaster-of-Paris, sealing wax, a mixture of shellac and sand, or shellac and sawdust, and asphalt, are suggested as materials from which to form the base or support of a composite record in Edison patent No. 430,570 of June 17th, 1890;

A mixture of gutta percha and resin to be applied to a foundation tube of muslin or paper is suggested in patent to Heysinger, No. 440,155 of November 11th, 1890. The same composition is described in patent to Heysinger No. 460,338 of September 29th, 1891, which in addition refers to hardening the mixture by the employment of more or less starch, or by a solution of chloride of zinc. The patent also suggests a mixture of gutta percha and a resin soap. It also suggests that linseed oil may be used as one of the ingredients, and that caoutchouc may be substituted for the gutta percha.

Boiled tar, pitch, resin, asphalt, and dental wax are suggested in patent to Herrington, No. 464,476 of December 1, 1891.

Wax, resin, and Plaster-of-Paris are suggested in patent to Edison No. 484,582 of October 18th, 1892. This is the first patent that refers specifically to the casting of molded records, but obviously the materials suggested are unsuited for the practice of the art at the present time.

A mixture of asphalt and Japan wax is suggested in the patent to Edison No. 488,191 of December 20th, 1892.

Ozokerite wax applied to a foundation of paper is suggested in patent to Wassenich, No. 505,910 of October 3d, 1893.

Celluloid is suggested in the patent to Lioret, No. 528,273 of October 30th, 1894. This patent describes a duplicating process in which a heated blank is expanded outwardly into contact with the mold, instead of being cast therein, as in the modern molded record art.

Hard rubber and celluloid are suggested in patent to Berliner, No. 548,623 of October 29th, 1895.

Sealing wax is suggested in patent to Berliner, No. 564,586 of July 28th, 1896.

The ordinary blank composition consisting of a mixture of stearic acid, stearate of soda, stearate of aluminum and ceresin, is suggested in patent to Macdonald No. 606,725 of July 5th, 1898. This blank composition was the development of my experimental work largely under Mr. Edison's direction in 1888 and 1889, and was put on the market in this country by the Edison Manufacturing Company and the Edison Phonograph Works as early as 1889, or more than seven years before the application for this patent was filed. Since 1889 all phonograph blanks have been made of this composition.

Cellulose and vulcanized rubber are disclosed in the patent to Lambert No. 645,920 of March 20th, 1900.

Celluloid is referred to in patent to Stevens, No. 650,431 of May 29th, 1900.

Vulcanite and celluloid are referred to in patent to Wolcott, No. 650,739 of May 29th, 1900.

Celluloid, a mixture of wax and rosin, water-glass, plaster-of-Paris, starch and bees' wax and rosin, are materials which are referred to for the manufacture of molded records in patent to Capps, No. 666,493 of January 22nd, 1901.

A mixture of metallic soap and ceresin is described in patent to Edison No. 667,202 of February 5th, 1901. This is the ordinary blank composition;

A mixture of stearate of soda, palmitate of soda, stearate of lead, oleate of lead, colophany or rosin, and ceresin, is disclosed in my patent No. 676,111 dtaed June 11th, 1901;

A mixture of stearic acid and ceresin is suggested in reissue patents to Macdonald No. 12095 and 12096 of March 10th, 1903. These patents also refer generally to soap mixtures, which would include the ordinary blank composition. These patents describe the manufacture of molded records.

A mixture of pyroxyline, camphor and a suitable adulterating pigment, such as zinc, white kaolin, baryta, magnesium, red lead or colored mineral earth, for the manufacture of molded records by a casting process is suggested in the patent to Petit, No. 683,-979, dated October 8th, 1901, which also refers to the formation of a surface coating of celluloid or pyroxyline composition.

Substantially the same materials are suggested in the patent to Petit, No. 689,117 of December 17th, 1901, except that for the formation of the surface coating, gelatine, lac, glue, gum, and colodion are suggested. In this latter patent to Petit, the process is one in which a blank is expanded in contact with the mold, and is not cast as in the modern art.

A large variety of materials and compositions for the manufacture of molded records made, however, by an expanded process are suggested in patent No. 713,209 to Edison of November 11th, 1902. These are the following:

(a) Asphalt,
(b) Stearic acid, or stearate of soda, mixed with chalk, slake lime, or lamp black,
(c) Sealing wax or shellac, mixed with chalk,
(d) Polished ebonite,
(e) Vulcanized hard rubber,
(f) Celluloid,
(g) Glue, either alone or mixed with chalk.

A mixture of bees' wax and rosin is suggested in patent to Jones, No. 727,960 of May 12th, 1903, as a blank composition.

In the examination which I have made above, I think I have included all the American patents in this art in which materials or compositions are suggested as suitable for the manufacture of blanks or for the manufacture of molded records. In none of these patents is there a recognition of the special conditions of the art, or of the desirable properties which a suitable molded record composition should possess. Nor is any composition described which I would consider as suitable for the manufacture of molded records, except in a very crude and ineffective way.

*Q.* 44. Of the many suggested ingredients for use in the manufacture of phonograph records that you found in the patents in this art, what ingredients would be suitable for addition to the ordinary blank material, if the only thing that had to be done was to increase its hardness?

*A.* The following are the materials which might be suitable for hardening ingredients:

Carnauba wax,
Asphalt,
Metallic soap,
Celluloid,
Glue,
Resins,
Magnesium Palmitate,

Gun cotton,
Ebonite,
Lead stearate,
Magnesium stearate,
Aluminum stearate,
Plaster-of-Paris,
Shellac,
Sand,
Sawdust,
Gutta Percha,
Sealing wax,
Stearate of soda,
Vulcanite,
Chromatized gelatine,
Rosin,
Colodion,
Chalk,
Slake lime,
Lamp black.

*Q.* 45. Please state how many of these ingredients could be actually used as an addition to the blank composition for the purpose of producing a satisfactory composition for the molded record art? *A.* Carnauba wax.

*Q.* 46. Why could not the others be used?

*A.* Because some of the materials, such as asphalt, celluloid, gun cotton, glue, ebonite, vulcanite, chromotized gelatine, and colodion, would not form a homogeneous mixture. Others, such as rosin, gutta percha, sealing wax, resins and shellac, and metallic soaps, like magnesium palmitate, magnesium stearate, aluminum stearate, and lead stearate, would not convey the proper properties of shrinkage necessary in this art. Stearate of soda, though possible as a hardening ingredient if added to the blank composition, is undesirable for the reason that it would make the material hygroscopic and would not resist wear effectively. Still others, such as sand, sawdust, chalk, plaster-of-Paris, lamp black and slake lime, might be mixed in the form of a fine ground powder, and would have a hardening effect, but the resulting surface would be too rough for the proper reproduction of the sound record.

*Q.* 47. Referring now to prior patents, which specially describe compositions for use in the molded record art, I first direct your attention to the Edison patents of February 5th, 1901, Nos. 667,202 and 667,662 respectively, and ask if the compositions described therein are suitable for the art and if not in what respects they would be unfitted therefor?

*A.* The compositions referred to in the patents are in one case a mixture of molten metallic soaps, and in the other case a mixture of a metallic soap or combination of several soaps, to which has been added a material not affected by water, such as ceresin. The latter material corresponds with the blank composition, to which I have already referred, and is not a suitable material for the practice of this art for the reasons which I have already given in detail. The blank composition is too soft and as I have already explained, does not possess the proper requirements as to shrinkage. A metallic soap without ceresin is equally unsuitable, because of its improper shrinkage, and further, because it would be very hygroscopic.

*Q.* 48. Having reference to your own patent No. 676,111, dated June 11th, 1901, is this composition suitable for the molded record art?

*A.* The composition referred to in patent No. 676,111, is a mixture of stearate and palmitate of soda, stearate and palmitate of lead, oleate of lead, colophony and ceresin. This composition was made for the purpose of molding records therefrom, but owing to its peculiar properties of solidifying, I was not able to utilize it for that purpose, although it made very good material for blanks, owing to its perfect homogeneity, the material being so free from crystalline structure that it was transparent or nearly transparent. It had the desirable properties of wearing well, but it could not be successfully molded, as a record, although it would be molded for use as a blank. The material had the property of shrinking away from the mold before the mass had become sufficiently hard to retain its shape. That is, the outer layer or the layer next to the bore of the mold would become hard enough to leave the mold whn the interior was still almost fluid, so that when the attempt was made to ream it the record invariably turned in the mold. The material furthermore, was very tough while warm, which made the reaming operation quite difficult, and when in a molten condition and at a temperature at which the molding operations were performed, the material was rather viscid and did not flow well into the indentations of the mold, so as to take a sharp impression.

*Q.* 49. Am I to understand from this patent that you did not take up, as a matter of course, the blank composition with the idea of modifying it, so as to fit it more perfectly for the molded record art, but that you attempted to make a completely new composition for that art?

*A.* That is correct. My knowledge of what had been done in the way of experimenting on molded records by Mr. Edison and Dr. Schultz-Berge, his assistant, using the regular blank composition and other compositions, led me to believe that it was not a desirable substance to work with, and I tried many other compositions before trying the blank composition at all. One of these compositions was that which is mentioned in the patent referred to in your last question. It was not until I had failed in making an entirely new composition suitable for the practice of this art that I came to a full realization of the desirable properties possessed by the blank composition and concluded that if it were properly altered to suit the new conditions, it might be used. As I have previously testified, I did not succeed in imparting to the blank compositon the desirable new properties which it should have without destroying any of the desirable properties which it already possessed, until the composition of the patent in suit was accidently discovered.

*Q.* 50. Please refer now to the two Macdonala reissue patents of March 10, 1903, No. 12095 and 12096 respectively, and state whether the compositions referred to therein are suitable for the practice of the molded record art?

*A.* In these patents a composition of stearic acid and ceresin is mentioned, and such a composition is not suitable for the practice of this art, for the reasons, first, it cannot be practically molded; second, it does not have the required wearing properties; and third, the material is not sufficiently coherent to leave the mold clean, which would result in a foggy surface on the record. Possibly, in these patents, the patentee may have had the blank composition in mind, as he refers to "the composition at present employed" and if this is so, I have already pointed out the undesirable properties of that composition for this art.

*Q.* 51. Kindly consider the patent to Petit, No. 683,979, dated October 8th, 1901, which refers to making molded records and state whether the composition referred to is suitable for the practice of the art?

*A.* In the patent referred to in your question, the composition mentioned, is pyroxylin and camphor, mixed with a quantity of pigments, such as zinc and kaolin and baryta, magnesium, red lead, colored mineral earth, or similar suitable materials. I do not consider that this composition would be suitable for the practice of this art even to the slightest extent by a casting process as described by this patentee. All modern molded records are now made by casting processes. This material does not become sufficiently fluid to lend itself to a casting process. Furthermore, the material would not present a sufficiently smooth surface to produce the perfect results which are necessary in this art, and the composition, on account of the volatile constituent (camphor), would change considerably after the record had been made, which would cause it to become distorted and with a roughened surface. Furthermore, this composition would not lend itself well to the manufacturing operation, as it would be difficult to remove from the mold by the method of shrinkage and longitudinal extraction. If sufficient pressure were used with the composition, it might possibly be molded, but this is not the present practice of the art, which requires a composition that can be perfectly cast. Furthermore, this would be a very expensive composition and even if it could be practiced successfully it would not be desirable because the operations would be so slow and tedious. The art requires a composition which can be molded rapidly.

*Q.* 52. Kindly consider the patent to Petit, No. 689,117, dated December 17th, 1901, and state whether this patent describes a composition or material that would be suitable for the practice of the art by a casting process?

*A.* The patent referred to in your question mentions a composition of celluloid, which is practically the same as that mentioned in my last answer, and is open to the same objections. In addition to the celluloid composition, mention is made of a surface film composed of gelatine, lac, glue, gum, colodion, or similar material. These materials are also open to the same objections as celluloid.

*Q.* 53. Kindly refer to Edison patent No. 713,209, dated November 11th, 1902, and state whether you find in this patent, suitable compositions or materials for the practice in the molded record art by a casting process?

*A.* The patent referred to in your question refers to the following materials or compositions:

(1) Asphalt,
(2) Stearic acid or stearate of soda, mixed with chalk, slake lime, or lamp black,
(3) Resins, such as sealing wax or shellac, mixed with chalk,
(4) Polished ebonite,
(5) Vulcanized hard rubber,

(6) Celluloid,

(7) Glue, either alone or mixed with chalk.

Taking these materials in the order which I have given them—

(1) Asphalt has the objections of being unmoldable; that is to say, it does not have the proper condition of shrinkage that would enable it to be gotten out of the mold.

(2) Stearic acid, or stearate of soda, mixed with fine precipitates, such as chalk, slake-lime or lamp black, would not be suitable, because I find such mixtures are too rough for the purpose of reproducing sound records and this material will have the objections of warping and irregular shrinkage, to which I have previously referred in connection with the blank composition.

(3) Resins, such as sealing wax or shellac mixed with chalk, cannot be molded by the casting process, as practiced in this art, for the reasons that they stick to the mold and do not have sufficient contraction to be removed therefrom.

(4) Ebonite is not suitable, because it does not become fluid enough to cast.

(5) Vulcanized hard rubber would have the same objection as ebonite.

(6) Celluloid has the objections pointed out in connection with the Petit patents.

(7) Glue alone, or mixed with chalk, is too sticky and cannot be removed from the mold. Furthermore, if it could be removed from the mold, it would not be suitable on account of it being susceptible to atmospheric moisture and it also warps, and in the case of mixtures of glue and chalk, they would be too rough for the proper reproduction of sound records.

*Q.* 54. Are your criticisms of the materials mentioned by Mr. Edison in his patent based on the actual knowledge of experiments with these specific compositions or materials, or are they based on your general familiarity with the art?

*A.* They are based on my knowledge as derived from witnessing experiments made by Mr. Edison and his assistants and from experiments which I have made myself.

*Q.* 55. Are you able to state of your own knowledge whether Mr. Edison at any time ever attempted to solve the problem of producing a satisfactory molded record composition suitable for this art?

*A.* Yes, I recollect that as far back as 1889, Mr. Edison made many experiments in attempts to mold duplicate sound records. In connection with these experiments, I made a number of compositions and witnessed the molding operations with them, but the results were never considered successful. I know that Mr. Edison worked for several years on this problem, during which time the molds were as perfect as they are now and the blank composition as now known was fully understood. The important problem was to produce a satisfactory composition.

*Q.* 56. Will you please explain in very general language the development of the commercial molded record art? ×

*A.* I entered the Edison Laboratory in the fall of 1887. At that time there were two talking machines on the market, one the Edison Phonograph, which was manufactured by the Edison Phonograph Works, and was later sold through the North American Phonograph Company, and the other the Graphophone, which was manufactured by the American Graphophone Company and was later also controlled by the North American Phonograph Company. The Edison phonograph in those days was a crude and imperfect machine as compared with the perfected instruments of the present date, but it contained the germ of the modern phonograph. More particularly, it made use of a blank that was in appearance, practically identical with modern blanks although the composition was relatively soft and sticky. The composition used was composed of a mixture of ceresin and carnauba wax. Improvements were made very rapidly, so that by 1890 the phonograph was a very perfect instrument and contained practically all the features of the modern machine. The graphophone, on the other hand, was a very different machine from the modern graphophone, and made use of a blank a little over an inch in diameter and about six inches long and was formed of a paper tube coated with a mixture, as I now recall, composed largely of ozocerite. No change was made in the graphophone blanks so long the the original form of machine was retained. Sometime in 1888, I developed the modern blank composition consisting of free stearic acid, stearate of soda, stearate of alumina and ceresin, from which all Edison blanks have been made from 1889 onwards, up to the present time. This composition was an enormous improvement over compositions formerly used, and made the Edison Phonograph a much better machine than the graphophone. From that time onwards, for several years, very few, if any, graphophones were used, as they appeared to have been entirely displaced by the Edison phonographs. At first, the phonograph was used largely for dictation purposes, but gradually a demand was created for musical records, from six to a dozen being made at the same time by the artist, band or orchestra, singing or playing simultaneously into a number of phonographs, so that the songs would be directly recorded on the blank of each. Later, the records were duplicated mechanically, by taking an original record and obtaining a duplication therefrom by transferring devices, whereby the reproducer engaging the original or master would actuate a recording stylus, so as to cause the latter to cut a copy of the record upon a blank. But these operations were slow, and since the original or master record would become quickly worn out, the quality of the duplicates was poor. About the year 1900, at Mr. Edison's request, I took up the work of developing a suitable duplicating process in collaboration with Mr. Walter H. Miller. This was very difficult work, since the conditions were new and we were dealing with an exceedingly delicate proposition, but we were quite successful, so that from the time the molded records were first put on the market by the National Phonograph Company on February 1st, 1902, until the present time, there have been no changes in the operation except the special refinements which would naturally come after several years commercial experience. Concurrently with our experiments in the developments of a suitable process, I myself, was working on the composition of the patent in suit, concerning which I have already testified. In my opinion, if that composition had not been invented, the molded record art would have been seriously handicapped. Many millions of records have been made by the National Phonograph Company of the patented composition.

Adjournmed to Wednesday, February 20th, 1907, at 10:30 A. M.

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ORANGE, N. J., Feb. 20, 1907.

Met pursuant to adjournment.

Present—Counsel as before.

Examination by Mr. AYLSWORTH is continued.

*Q.* 57. Will you produce a copy of the patent covering the process referred to in your last answer as having been developed by Mr. Miller and yourself?

*A.* I produce a copy of this patent, which was granted October 1st, 1901, and numbered 683,615.

*Q.* 58. Referring now to the experiments which you state were made for the purpose of comparing the patented composition with certain other compositions, and referred to in answer to *Q.* 12, when were those experiments made?

*A.* In the latter part of December and during the first two weeks in January last.

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*Q.* 59. Were these experiments observed by any one except yourself?

*A.* Yes, they were witnessed by Messrs. Holden, and Dodd, as to the making of the composition, and by Messrs. Holden and Nehr, as to the molding of the records from the composition; the inspection was witnessed by Messrs. Holden, Sturms and Payne. Of course, the actual molding of the records and the inspection was done by operators in the factory who regularly do that work.

*Q.* 60. Please explain now what particular compositions were made for the purpose of these experiments, giving the ingredients, temperatures, and methods of manufacture in each case?

*A.* The following compositions were made; designated respectively, A, B, C, D, and E:

Composition A is the composition of the patent, omitting the ceresin and carnauba and lamp black ingredients. This composition is what is known in the factory as "hard regular," and it was made to use as a basis for forming the other compositions, B, C, D, and E.

Composition B is a recording blank or tablet composition; that is to say, the composition of the patent, less the carnauba and lamp black ingredients, it differing from A in that it contains ceresin.

Composition C is composition A plus both ceresin and carnauba wax in the proportions of the patent in suit and is in all respects the same as the patent in suit with the exception of the omission of the lamp black, and the temperature of making the wax was kept low, the temperature not exceeding 320° F., at which temperature no reactions appear to take place as evidenced by foaming.

Composition D is composition A to which carnauba and ceresin are added in substantially the proportions used by defendant and at the temperatures practiced by defendant, which was practically the same as that of the Aylsworth patent, the only difference being a somewhat smaller percentage of carnauba than that mentioned in the patent.

Composition E is composition A with carnauba, ceresin and lamp black in the proportions of the patent, and formed by the same methods as mentioned in the patent so as to produce the reactions between the carnauba and the balance of the composition.

The carnauba wax used in these experiments was the regular article of commerce which had been previously washed with boiling water; then, after separating from the water, it was heated to drive off any contained water and then filtered. In order to supply enough material to fill the dipping tank with each experiment, it was necessary to make in all about 1600 pounds of composition A, the base composition from which the others were formed. Each separate experiment required about 450 pounds. This composition A was thoroughly foamed off at 440° F. before filtering. It took about an hour to foam off the material so that it became perfectly free from scum or foam. After filtering, the material was poured in pans and cakes formed of it, which were marked by Mr. Holden and myself. This material was set aside to be used for the compounding of the four compositions used in the experiment. The proportions of the ingredients used in forming composition A were—

800 lbs. stearic acid,
3616 grams of Caustic soda,
1400 grams of sheet aluminum,
172 lbs. of sal-soda,

These materials were mixed in the same manner as described in the patent and are in the same proportions with the exception of the omission of ceresin, carnauba and lamp black. The material was made in two lots, using the same charge and proceeding in the same manner with each lot.

Composition B was formed by taking 450 pounds of composition A, and adding thereto 94 pounds of ceresin. Composition A was first melted at a temperature raised to 390° F. when the 94 pounds of ceresin was added, and the temperature increased to 440° F. and filtered. No foaming whatever took place. The composition was started at 10 A. M. December 28th, 1906, and was finished on the same day at 1.30 P. M. The congealing point was tested by Mr. Dodd and was found to be 290° F. After filtering the wax was transferred to the dipping tank and the temperature allowed to fall at 290° F. and the dipping started. 93 records were dipped, and each record was allowed to stand on the cores for about two hours. They were then set aside to be put through the finishing operation and the regular factory inspection, which was done on the following day, the results of which and of the other composition which were made are tabulated on one sheet for purposes of comporison, which tabulation will follow after the description of the balance of the composition. The molding was done under the personal supervision of Mr. Nehr, Mr. Holden and myself witnessing them. The finishing and part of the inspection were done in Mr. Sturm's Department; the final inspection was done in Mr. Payne's Department. The other compositions, namely C, D and E, were molded finished and inspected in the same manner and by the same operators, as was done with composition B.

*Composition "C."*

433.1 lbs. of composition "B" (which contains
358.3 lbs. of composition A,
74.8 " " ceresin)

was melted and brought to 350° F. and 72.5 of the purified carnauba before mentioned was added, which brought the temperature down to 310° F. The temperature was then raised to 320° F. and held for a short time. The total time for making the composition from start to finish was about four hours. The congealing point was regulated by Mr. Dodd to make it exactly the same as with composition B, namely 290° F. After filtering the wax was transferred to the dipping tank and 65 records were molded under practiclly the same conditions as were maintained with the molding of composition B. These records were set aside to be finished in the same manner as composition B.

*Composition D.*

412.5 lbs. of composition A is melted and brought to 400° F. and 57.6 lbs of the purified carnauba was added and the temperature then raised to 460° F., and held at this temperature for two hours before adding ceresin, 70.5 pounds of which material and pounds of lamp black were then added and the temperature maintained at about 460° until all foaming ceased, which took about 5½ hours from the time the carnauba wax was added. Foaming began to form soon after the carnauba was melted, and the foam raised to a height of 5 inches over the surface of the composition so that there was a continuous formation of foam and ebullition of gas for nearly four hours. It ceased to foam while the temperature was still maintained at 460° and the temperature even raised higher than 460° toward the end without producing more foaming. The congealing point of this composition was regulated by Mr. Dodd to 290° the same as in the other compositions. The material was filtered and transferred to the dipping tank and 95 records molded under practically identical conditions as Compositions B and C. They were finished and inspected under the same conditions and by the same operators as those made from compositions B and C.

*Composition E.*

Composition E was formed by heating that which was left of composition C to the temperatures of the patent and adding thereto the lamp black in the proportions of the patent. In other words composition E is absolutely identical with composition C excepting what physical changes may have taken place by reason of the high heat and the reactions consequent to the high heat. The batch was started at 9.25 A. M. January 3d, 1907, and at 10 A. M. the temperature was 450°. The foaming began as soon as the temperature got over 400° and soon raised to a height of about six inches over the surface of the composition. At 1.35 P. M. the wax was still foaming strongly and at 2 P. M. foaming had practically ceased. The congealing point was then regulated to 290° the same as in the other compositions, and the composition was molded, finished and inspected in the same manner and by the same operators as in compositions B, C and D. 86 records were molded from this composition.

*Tabulated results of the four experiments, B, C, D and E, are as follows:*

| | *No. Molded* | *Cracked & Broken* | *Chipped Edges* | *Blow Holes* | *Broken in handling* | *Not round & Run Out* | *Good* | *% Good* |
|---|---|---|---|---|---|---|---|---|
| B | 93 | 10 | 6 | 5 | 2 | 56 | 14 | 15 |
| C | 65 | 17 | 7 | 8 | 0 | 23 | 10 | 15.4 |
| D | 95 | 18 | 8 | 4 | 0 | 35 | 30 | 31.6 |
| E | 86 | 7 | 7 | 4 | 0 | 40 | 28 | 32.5 |

*Q.* 61. Am I correct in understanding that as to the four compositions referred to in your last answer, composition B, is the ordinary blank composition, which you have frequently referred to; composition C is the exact composition of the patent made at a low heat insufficient to effect chemical reaction; composition D is the composition used by defendant, being that of the patent with a smaller amount of carnauba wax, and composition E is that of the patent made at a high temperature?

*A.* You are correct.

*Q.* 62. In answer to *Q.* 60, you refer to "dipping." What is this operation?

*A.* By "dipping," I mean the molding or casting of the record.

*Q.* 63. Having reference to the table which you give at the end of your answer to *Q.* 60, do I understand that this is based entirely on your own observations, or is it based on the reports of others?

*A.* It is based partly on my own observation and partly on the reports of Messrs. Sturms and Payne. I personally witnessed together with Mr. Holden, the finishing operations and the first inspections. Also, most of the molding operations in each case.

*Q.* 64. Do I understand correctly that the figures given in the first column of this table represent all of the records molded from the several compositions?

*A.* No, these were not all of the records molded of the several compositions. As a matter of fact of composition B, 103 records were molded and ten were rejected for defects which were not due to the composition, and in composition C, 101 were molded and thirty-six were rejected for defects not due to the composition, and in composition D, 99 were molded and four were rejected for defects not due to the composition, and in composition E, 103 were molded and 17 were rejected for defects not due to the composition.

*Q.* 65. What were these defects that you say were not due to the composition and because of which certain of the records were rejected?

*A.* They were defects which are known as "rings;" that is, concentric lines formed around the surfaces of the records, due to the speed at which the mold was lowered into the wax composition. Another defect was wax chips, which is caused by little particles of wax, breaking off from the record at the ends, usually in withdrawing from the mold; these being electrical are frequently attracted inside the mold and stick on the surface of the mold leaving an imperfection. Another defect is what we called "bruised;" this is due to mechanical injury to the record surface, due to handling. Dirty mold, another defect, would ordinarily be due to the composition, but in these experiments it was thought best to have the mold cleaned wherever they showed any smeary appearance, as this could be done readily with any composition. Another defect is "surface scratches," which is due to withdrawing the record from the mold and may occur with any composition.

*Q.* 66. Suppose these records had not been rejected because of these defects, would the result have been substantially different from that shown in your table?

*A*. If these defects had been counted it would not have materially changed the percentages shown in the table.

*Q*. 67. Having reference now to this table, and taking up the first reason for rejection, namely, "Cracked and Broken," what connection is there between this matter and the several compositions?

*A*. It indicates brittleness, but of course the records lost from this cause are not due entirely to the composition, as there are always from any composition losses from this cause which will vary considerably, but in the case of an extremely brittle composition, of course the losses on this account would be very marked.

*Q*. 68. What about the defect of "Chipped Edges"?

*A*. The brittleness of the composition would cause chipped edges to take place more in one case than in another; that is to say if there were great difference in the brittleness of the material, there might be more chipped edges than would be the case with a softer, tougher material. In this respect also, the handling of the records would cause chipped edges without regard to the composition.

*Q*. 69. Now please consider the question of "Blow Holes" and state what bearing, if any, this has upon the composition?

*A*. "Blow holes" are ordinarily present in a small degree in the best compositions obtainable, due to mechanical agitation of the material, but if the composition contains much decomposable material, so that it was constantly giving off gas, in that case there would result blow holes in the records, directly due to the composition. In these results, however, while we have counted the blow holes as a defect due to the composition, yet, their proportions is in only one case large enough to be attributable to the composition. With this composition, the temperature was purposely kept very low in making the composition and possibly there were some decomposition products which gave off a little gas during the molding operation. This is composition C.

*Q*. 70. Now take up the next defect, namely "Broken in Handling," and state what, if any, bearing this has on the composition?

*A*. The losses in this case were only 2 in composition B, and they were purely accidental and had nothing to do with the composition. They are included here merely to account for the record.

*Q*. 71. Now consider the final defect, namely "Not round and

Run Out" and state what these expressions mean and what bearing, if any, they have on the respective compositions?

*A.* These defects are due to warping and is a property inherent in the composition. The particular kind of warping, which is called "not round" means an eccentric or slightly oval record, and that which is called "run outs" is an uneven warping which distorts the record groove and tends to cause the reproducing stylus to jump from one record groove to another.

*Q.* 72. As I understand this table then, the two principal defects which are encountered in molded record compositions relate first to warping or irregularities in shrinkage, and second to brittleness. Is this correct? *A.* Yes.

*Q.* 73. Is it a fact that under commercial operations with the patented composition only about 32% of good records are secured?

*A.* No, in commercial operations, we get a considerably larger percentage of good records, but in order to make comparison, which would be as fair to one composition as to another, we put these through a more rigid inspection as to defects than would be practiced in commercial work. We put them through the same sort of inspection which we give our regular composition, when any change is made therein as to altering percentages. It is also the same inspection which we make for our molded masters.

*Q.* 74. Was the inspection the same with one composition as with the others?

*A.* It was exactly the same in each case.

*Q.* 75. Were the results which you obtained with each of these compositions substantially what you would have expected to obtain from your experience in this art?

*A.* The general trend of the result is substantially what I would expect, although in the case of composition B the results were better than I had expected to get. In fact in the earlier days or stages of the molded record art, we were not able to get anything like as good a result with the blank composition. The results that we got in these experiments with the blank composition are due to the fact that at the present time the art is so well known that it becomes possible to mold almost any compositon with at least some degree of success.

*Q.* 76. Would it be a fair statement of your opinion based upon your experience in this art, to say that at the present time when the art has been developed to a high state of perfection, with the patented composition the percentage of good records would be at least twice as high as with the blank composition molded under the same conditions?

*A.* Yes, as to the percentage passable if we consider the defects as noted in the table; but in addition to these defects, the quality of the records produced by the blank composition was inferior to that produced in the other or patented composition, because of a persistent foggy surface which these records made from the blank composition have, which though it disappeared on burnishing, left what we call a bad surface, and we would not use a composition which would give this defect even though it were perfect in every other respect as to its molding property.

*Q.* 77. Then, as I understand it, if in addition to the difficulties which arise in the molding operation, we consider the character or quality of the record surface the percentage of good records which can be molded from the patented composition is more than twice as great as can be molded from the blank composition under the same circumstances?

*A.* Yes, that is correct.

*Q.* 78. It appears from this table which we are discussing that so far as concerns the results, which relate to the molding properties of the several compositions, there is no substantial difference between the composition containing the proportion of carnauba, specified in the patent in suit, or the somewhat smaller proportion of carnauba used by defendant. Is this correct?

*A.* Yes, that is correct, there is practically no difference.

*Q.* 79. Would there be substantially any difference in the quality or character of the records made from the two compositions?

*A.* There would be a slight difference as to the number of times they could be reproduced without wearing out, but otherwise there would be no difference. The patented composition would be somewhat more durable.

Adjourned to Thursday, February 21st, 1907, at 10.30 A. M.

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ORANGE, N. J., February 21, 1907.

Met pursuant to adjournment.

Present—Counsel as before.

CROSS-EXAMINATION, by Mr. MASSIE:

> Defendant's counsel enters timely objection to the statement by complainant's counsel in questions 38, 39 and 42, as to defendant's contentions in this case. Complainant's statements may, or may not, be correct.

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xQ. 80. Does the presence in the metallic soap composition, for instance, your "hard regular," of the wax-like compound ether obtained from carnauba wax, render the composition more limpid?

A. Interpreting the word "limpidity" as meaning more mobile or fluid, the addition of the carnauba wax and waxlike ether contained therein and produced by reactions that take place during the making of the wax composition does increase the limpidity to a perceptible extent; that is to say, perceptible not to the eye direct, but by the aid of physical instruments, such as a viscousity meter.

xQ. 81. Your answer is not quite responsive to my question. If you add carnauba to what you have been calling your "blank composition," but do not employ the temperature called for by the patent in suit, am I correct in understanding, first, that in your opinion the wax-like ethers are not produced; and if I am correct, would the presence of the thus unmodified carnauba increase the limpidity?

A. In my opinion if the carnauba wax is added to the blank composition and the temperature kept down to about 300°, there would not be additional wax-like ethers formed, other than those contained in the carnauba wax. The composition in this case would be more fluid or limpid than the blank composition. In other words, whether the composition was heated during the manufacture of the wax to the high or low temperature would not materially affect the limpidity or fluidity of the composition.

xQ. 82. Are you familiar with the composition set forth in the Macdonald patent No. 606,725 of July 5, 1898, and of Macdonald patent No. 626,709 of June 13th, 1899, which have been offered in evidence by defendant?

A. Yes, I am familiar with these patents and recognize them as the ones involved in the companion suits. I was familiar with the compositions therein disclosed a long time before the dates of the applications for those patents.

All but the word "yes" objected to as volunteered.

xQ. 83. Have you ever added carnauba wax to that Macdonald composition, with the temperature called for by the second Macdonald patent referred to, and also, with a lower temperature of about 300° F.; and if you have done so, what did you observe with regard to limpidity as compared to the limpidity of the same composition without any carnauba?

Mr. Dyer—I assume that by the expression "Macdonald composition" counsel intends to refer only to the "composition of the Macdonald patents." Otherwise, the expression is believed to be misnomer.

*A.* I have tried the experiments of adding carnauba wax to our blank composition, which is essentially the same as the composition referred to in the Macdonald patent, both heated to a temperature of about 300° and to a temperature of about 460°, and the limpidity I believe in either case will be the same. But I have not made accurate limpidity or viscousity tests on these two compositions for comparison. I have made the limpidity tests on the composition containing carnauba heated at the low temperature in comparison to the same composition plus lamp black and heated to the high temperature, and in this case the limpidity of the composition containing lamp black was just about the same as the blank composition containing no carnauba, and the composition containing carnauba and not containing lamp black and heated at the low temperature was more fluid than either of the other compositions. The presence of the lamp black reduces the limpidity to a slight extent so as to just about neutralize the increased limpidity, due to adding carnauba.

*xQ.* 84. What is the effect, as regards limpidity, of adding ceresin to a metallic soap composition, containing no carnauba?

*A.* It would have the effect of increasing the limpidity.

*xQ.* 85. How do you know this and when did you first ascertain the fact?

*A.* At the time the experiments were being made on the record composition. At that time, I did not test them with any form of a viscosity meter, but just by noting the results of molding the composition.

*xQ.* 86. When did you first ascertain from literature or otherwise that carnauba wax when molten is more limpid than the metallic soap composition at the same temperature, and that the presence of carnauba increases the limpidity?

*A.* I do not recall just when I made this observation, excepting that I do remember that when making the experiments this property was recognized by me as being a desirable thing in compositions.

*xQ.* 87. Is it not a fact that the property of being comparatively very limpid, that is, non-viscous, when molten is inherent in carnauba; and whenever carnauba was melted and cooked with other less limpid compositions the result of increased limpidity would always take place?

*A.* No, it is not a fact that it could be mixed with any substance or composition, and result in increased limpidity; for instance, if carnauba wax is mixed with a composition containing an excess of caustic soda, or other alkali, the alkali would combine with the carnauba wax and result in a viscid mass, and if the caustic soda were in a sufficient amount, there might be a material which could not be used at all without charring. A composition of this sort might be made in the following manner:

Paraffin or ceresin might have added thereto say—20% of stearic acid, and say—3 times as much caustic soda as would be necessary to completely saponify the 20% of stearic acid, leaving therein a large excess of caustic soda; then if carnauba wax were added the soda combining with the carnauba would result in a more viscid composition. Carnauba wax considered alone, or admixed with materials whereby no combination, such as I have just illustrated takes place, would naturally result in increased limpidity, providing the substance with which it was mixed was in itself more viscid than the carnauba wax.

*xQ.* 88. How long have you been familiar with the fact, from literature or otherwise, that molten carnauba is comparatively very limpid, and that it mixes readily with wax-like compositions (metallic soaps or otherwise) provided there be not an excess of alkali present in the mixture?

*A.* From literature I have not been aware of these facts; my personal observations with carnauba wax since the early days of experimenting with wax-like compositions have taught me that it was when molten, quite limpid, but as to its being miscible with all wax-like compositions my earlier experiments have taught me that it is not miscible with all wax-like compositions. There are many cases which I can recall where experiments were actually made where carnauba wax is not miscible with such wax-like compositions, instances of this being attempts to mix carnauba with shellac, with certain asphalts, with certain metallic soaps, such as resinate of magnesia, resinate of lime and many other substances. The fact that asphalt does not mix with stearate of soda would lead to a serious doubt as to whether carnauba wax would mix with stearate of soda. Asphalt, however, will mix with other true vegetable waxes and some forms of asphalt will mix with carnauba wax. These things have to be all determined by experiment.

*xQ.* 89. Are resinate of magnesia and resinate of lime fusible?

*A.* Yes, at quite a high temperature.

*xQ.* 90. What was the specific gravity of each of the two compositions whose limpidity you compared as stated in answer to *Q.* 4, or at least how did they compare as to specific gravity?

*A*. I have not as yet made a specific gravity test, although I expect to make one. My tests were made with a simple form of viscosity meter, as I have already described.

*xQ*. 91. If you will, I should be glad if you would ascertain the specific gravity of a composition produced in accordance with the two Macdonald patents of 1898 and '99 respectively, named in *xQ*. 82; the specific gravity of carnauba; and the specific gravity of the first-named composition containing carnauba in the amounts used by defendants? For the purpose of this determination, my recollection is that you have obtained some specimens of the special records produced by our witness Thornberry.

By Mr. Dyer—Perhaps it might be well to state on the record what has already been explained to counsel for defendant. The purpose of the present deposition of Mr. Aylsworth is to obtain his opinions concerning the statements of his patent as well as to testify to certain facts. Later it is proposed to have him testify in reply to the depositions of defendant's experts Holton, Cameron and Munroe. In the interval the tests requested by counsel for defendant can be made as well as any other tests or experiments that counsel may request.

*xQ*. 92. In answer to *Q*. 5 you refer to "decomposition products" etc., what ingredient, or what step, in the patent in suit removes or prevents the presence of decomposition products?

*A*. Selection of the different ingredients, purifying the same by washing and by filtration and filtration of the resulting composition. Of course if the materials were not pure, the high heat would eliminate the cause of gas bubbles.

*xQ*. 93. "Selection of materials"—suppose the materials had been absolutely purified, and the resulting composition has been properly filtered, and the high heat has been employed, the omission of what ingredient or ingredients from those entering into the composition of the patent in suit, would result in the presence of decomposition products?

*A*. As I understand your question you mean that if any one of the ingredients had been omitted, you would still have a product free of decomposition products, provided the precautions noted in my previous answer had been followed. On this assumption, I answer—yes.

*xQ*. 94. Then, the freedom from decomposition products is due entirely to the purity of the ingredients the carefulness of manipulations and the high temperature?

*A.* Yes, to these and to prolonged heating at a high temperature. I would state, however, that if the ingredients were all pure and free from the causes of decomposition products, that the high temperature would be unnecessary.

*xQ.* 95. As a matter of fact, are the materials entering into the composition of the patent in suit, if pure, "free from the causes of decomposition products"? By decomposition products in this connection, I mean deleterious products only.

*A.* They would be free from the causes of decomposition products, other than the products of reaction which are eliminated at a temperature around 300°. By this I mean the water and carbonic acid gas, which are expelled during the making of the wax. They, of course, would be objectionable products if not removed by cooking a sufficient time at the temperature whereby they are driven off. In the case of carnauba wax, if the temperature is kept low, there would be no decomposition products evolved, but if the temperature were increased during the use of such material up to the neighborhood of 400°, there is evolved gas which manifests itself as bubbles and foam in the material. These would be, of course, objectionable, but if the material were used at temperatures below this I do not think it could be considered as containing objectionable decomposition products.

*xQ.* 96. Can you answer yes or no to the question whether in carrying out the manufacture of the composition of the patent in suit, assuming that you have absolutely pure ingredients, and employ filtration with utmost care, is or is not the prolonged high temperature necessary in order not to have deleterious decomposition products?

*A.* Under the conditions of purity and care which you mention, I do not consider that the high temperature would be necessary to avoid decomposition products, but that it would be necessary to make a composition having the desired properties as described in the patent in suit as to the molding qualities. As a matter of fact, the composition designated "C" in answer to *Q.* 60, is such a composition in respect to the carnauba ingredient and did not show any of the deleterious effects due to the decomposition products. This composition, however, was made from a blank composition which had been subjected to the high temperature previous to adding the carnauba.

*xQ.* 97. Near the close of your answer to *Q.* 5, you are viewing your composition in suit as consisting of the old blank composition which you regard as substantially the same as what I call the "Macdonald composition") "modified by the addition of a new ingredient added in a new way to produce new results." Assuming that the "new ingredient" is carnauba, what is the "new way" in which it is added?

*A*. The "new ingredient added in the new way" as referred to in answer to *Q*. 5 is carnauba wax added to the blank composition and heated for a sufficient time to a temperature about 450° to produce certain reactions, which are evidenced by a copious ebullition of gas and which reaction begins in the neighborhood of 400°, and continues for a considerable time, amounting to several hours, even when the temperature is raised to 460°. If the temperature were maintained at a somewhat lower degree for example, at the point where the reaction begins to take place, a very much longer time would be necessary to complete the material.

*xQ*. 98. The "new way" of adding carnauba, then, is to maintain the comparatively high temperature of about 450° until the foaming off has practically ceased?

*A*. Yes, that is what I mean by the new way. To make this more clear I would state that the old way to make such mixtures was to add the ingredient to the blank composition which had previously been foamed off and after a thorough mixture of the molten material, which in such experiments usually was done at a relatively low temperature compared to the temperature used in foaming off to remove decomposition products. In my experiments, in adding various substances to this composition, a temperature from 320 to 350° was generally used. At that temperature the blank composition was sufficiently fluid, and the substances which were mixed therewith were also sufficiently fluid and there resulted a composition which so far as decomposition products are concerned was all right for the purposes that the composition was intended for, and it was only quite accidently that the reactions which take place at higher temperatures were noted.

*xQ*. 99. What ingredient was added to the blank composition in the "old way"?

*A*. Many ingredients were used, among which were asphalt, shellac, resins, various gums, and hard wax-like materials, and also carnauba.

*xQ*. 100. The "new way" of adding carnauba which consists of maintaining the high temperature for a considerable period of time, results according to your opinion in (1) producing the compound ethers from the carnauba and the free stearic acid, (2) eliminating any deleterious decomposition, and (3) permitting the process to be completed in a shorter time than if a lower temperature were employed. Do I correctly state your views; and is any other result produced?

*A.* Yes, anssuming that the temperature is high enough to cause the reactions referred. So far as any other results being effected than those stated in your question, I do not recall any.

*xQ.* 101. Please assume for the purpose of this question, that the reaction between carnauba (or any ingredient thereof) and the free stearic acid, results in so small a product as to be negligible: then, would not the only results of maintaining the high temperature referred to be to drive off any deleterious decomposition products and to expedite the completion of the process?

*A.* If we assume that there are no compound ethers formed other than those contained in carnauba, or in other words, that there is no reaction or a purely negligible reaction between the carnauba wax and the free stearic acid of the composition, the physical properties of the composition as altered by the temperature under this assumption must be due to something else, and the high heat might cause other reactions which are not known. I, however, do not admit the correctness of this assumption, even if it were proved that there was an extremely small reaction and consequent product of that small reaction. It would still be reasonable to believe that they might have a relatively great influence in the physical properties of the resulting composition. An example of such small reaction and great physical change due to the same, is seen in the blank composition, where no carnauba wax is used. Here we find it necessary to add approximately 1/10 of one per cent. of aluminum, which produces a great effect in the resulting composition; namely, the prevention of crystallization. If this minute quantity of aluminum were not added, the composition would be utterly worthless.

*xQ.* 102. Do you recall a statement in patent literature that the continued application of heat changes the physical properties of the substance known as ozokerite, even when taken by itself, rendering it *tougher*?

*A.* I recall the statement to which you refer, and I agree that with the substance known as ozokerite, which is the crude form of ceresin, that prolonged heating at a high temperature would tend to harden or toughen the material, for the reason that crude form of ceresin, known as ozokerite, is quite variable in its degree of hardness and toughness, due to oily components, which when driven off by heating to a high temperature leave the true higher hydrocarbon of ozokerite in a more pure form. On the contrary, ceresin which is already pure, is not so toughened by prolonged heat at a high temperature, and as a matter of fact, ceresin which is the highly purified for of ozokerite, if heated to a high temperature for a considerable time, is comewhat softened by the procedure.

*xQ*. 103. Will you please make plain what difference, if any, there is between "hardness" and "toughness" in referring to these phonograph compositions?

*A*. The term "hardness" and "toughness" in a measure go together, but it is possible to have a hard brittle substance and a hard tough substance. That is, one substance may be hard as evidenced by cutting with a knife, which removes a shaving, which hangs together more or less, and another substance may be hard and not so tough in which instance upon cutting with a knife, there would result a powdery shaving. The difference between purely a hard substance, and a hard and tough substance, can be noted in the composition C, as compared to composition E, referred to in my previous answer to *Q*. 60. The difference in this respect between these two compositions is not great, but it can be noticed by one skilled in examining such compositions, and is also apparent by wear tests.

*xQ*. 104. Comparing two such compositions, where the thread cut from one remains integral, while the thread from the other breaks up, are the two materials equally amorphous, or is not the latter somewhat more crystalline?

*A*. No, they are equally amorphous, I should say, and I attribute the greater toughness of one to the formation of some reaction product, and not to heat alone, because I had treated the blank composition at both the high and low temperatures, and have not noticed any increase of toughness in this composition, due to heating to the high temperature.

*xQ*. 105. In a recent answer you adduce the comparison between composition "C" and composition "E," as showing that the latter is tougher; does a similar comparison between composition "D" and composition "E" show that the latter is tougher, as indicated by the fewer number of broken records?

*A*. I do not consider that the number of broken records would be an accurate indication of the difference in toughness between the compositions "D" and "E," unless the collective results of handling many thousand records by the same operators of each composition could be compared. The cracked and broken records are the result of accident in handling as well as brittleness of composition, and unless the very large average numbers in each case were compared, whereby the results of accident would become more uniform, differences due to brittleness, would not be apparent. The wear test is a more accurate indication of toughness in these compositions.

*xQ*. 106. Then, as I understand you now, the figures under the column "Cracked and Broken" at the end of *Q*. 60, are not reliable indications of comparative brittleness or comparative toughness? *A*. No they are not.

*xQ*. 107. Is the same true of the figures in the next column, "Chipped Edges"?

*A*. Yes, it is true also in this column, as these defects are also due to a combination of causes.

*xQ*. 107. Are the figures in the next three columns (Blow Holes, Broken in Handling, Not Round and Run out) reliable indications of comparative brittleness or comparative toughness?

*A*. The column under the heading of "Blow Holes" has nothing to do with the question of toughness or hardness. The column under the head of "Broken in Handling" has nothing to do with toughness; as I remember, these, two records. Under the column "not round and run out," I do not consider that the defective ones here are an indication of toughness or brittleness, but rather an indication of warpage.

*xQ*. 108. Is it your belief, however, that the composition of the patent in suit is tougher than the blank composition, though not so tough as the composition of the patent when the temperature does not exceed 300° F.?

*A*. It is my belief that the composition of the patent in suit is both tougher and harder than the blank composition, but that it is not so hard, though tougher than the composition "C," which latter composition was foamed at a low temperature.

*xQ*. 109. What tests have you made as to the comparative toughness and as to the comparative hardness of composition "C" and composition "E"?

*A*. As to hardness, I have submitted the composition "C" and composition "E" to a needle test. As to toughness, the wear tests on these two compositions show more toughness in "E" than in "C."

*xQ*. 110. That one sound record will endure longer under the wear test than another is due to its greater toughness, rather than to its greater hardness—is that your hypothesis, or is that a demonstrated fact?

*A.* I know it to be a fact that both toughness and hardness combined give the best wear.

*xQ.* 111. Have you ever attempted to use the composition disclosed in the Petit U. S. patent No. 683,979 referred to in your direct examination; or if not, have you any information as to the behavior of such composition other than gained from that patent itself?

*A.* This patent refers to molding by pressure and while I am familiar with some of the materials mentioned in this patent mixed with the molten blank composition I have never attempted to incorporate them all in a molten composition, such as the patent in suit. I am, however, familiar with the properties of the ingredients mentioned.

*xQ.* 112. I show you copy of U. S. Letters Patent No. 787,001 to Sanders, dated April 11, 1905. This patent names as one of the ingredients of the composition for sound records "natural oxide of iron." Is that material in your opinion gritty; and what can you say as to the quality of a record made of the materials set forth in this Sanders patent?

*A.* There are many forms of natural oxides of iron; it is my belief that they all of them contain gritty substances, and that a record produced from such a composition would be rough and noisy compared to a record produced with the patent composition of the patent in suit.

*xQ.* 113. You observe, do you not, that this composition of the Sanders patent is indicated as being for disk records, which are made by impressing, as you just now observed that the record of the Petit patent 683,979 was made by pressure?

*A.* Yes, I observed that this patent refers to disk records formed by pressure. It is possible, however, that a mixture of the natural iron oxide when pressed into the record surface might be smoother than if the same oxide of iron were incorporated in a molten mixture, such as the patent in suit.

*xQ.* 114. Is it a fact, speaking generally, that the presence of gritty substances, or relatively gritty substances, like chalk or fine precipitates, in a record composition that is to be used for casting records (as distinguished from applying pressure) does not give good results and is undesirable.

*A.* If the substance is not sufficiently fine, so that there would result gritty particles in the composition, I think it would be undesirable, but if the precipitate is extremely fine like lamp black, or certain forms of precipitated iron oxide, or chalk, it would be desirable providing they would not separate out, due to their greater specific gravity. In case of lamp black, while it is of higher specific gravity than the wax composition it is so extremely fine that it does not separate out and is not undesirable.

*xQ.* 115. Would a person skilled in this art be liable to employ in a composition to be used for casting sound records a substance that is manifestly gritty or relatively coarse in its particles?

*A.* A person skilled in this art might experiment with such substances, with a composition capable of being cast but I don't believe they would find the results sufficient to warrant the use of such composition.

*xQ.* 116. If a person skilled in this art had your ordinary blank composition and wished merely to harden it, and if he had before him two ingredients each of which would harden the composition and was apparently miscible therewith, one of which was relatively coarse or gritty, while the other was not; to which do you think he would naturally first turn?

*A.* If the relatively coarse and gritty substance were miscible, that is, soluble in the composition, I think he would be pretty apt to experiment on both of them before deciding.

*xQ.* 117. Which do you think a person of ordinary intelligence would attempt first?

*A.* If he had knowledge that the gritty coarse particles would remain as such after mixing them, he would most probably try the others first.

Answer objected to as not responsive.

*xQ.* 118. Will you please specify which method you employed in molding the records from compositions "B," "C," "D" and "E"?

*A.* In all of these compositions the process described in the patent in suit. I have reference to the Miller and Aylsworth patent described in the patent in suit.

*xQ.* 119. You refer to Miller & Aylsworth patent No. 683,615 dated October 1, 1901, in which the mold is dipped into a vessel containing the molten composition. Is the mold heated, or at normal temperature at the instant it is dipped into the molten composition?

*A.* The mold is somewhat warmer than the normal temperature at the instant of dipping.

*xQ.* 120. I am not asking as to what the patents describe, but inquire about what actually took place when making the records from compositions "B," "C," "D" and "E." Was the mold allowed to remain in the molten material long enough to acquire anywhere near the temperature of that material?

*A.* The mold was left in the molten material two minutes, during which time it does attain somewhere near the temperature of the molten material.

*xQ.* 121. The particles of the molten material that first come in contact with the surface of the mold meet a surface that is comparatively cold, do they not?

*A.* That is correct, compared to the temperature of the molten material.

*xQ.* 122. Have you made any comparative tests of compositions "B," "C," "D" and "E" by molding records in a mold that was either previous to heating to about the same temperature as the molten composition, or that was subsequently brought to about the same temperature while the composition remained in the mold?

*A.* I have not, but it is my belief that the results would be essentially the same however they were molded, providing each composition received exactly the same treatment.

Adjourned until Friday morning, February 22d, 1907, at 10.30 A. M.

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ORANGE, N. J., February 25, 1907.

Met pursuant to adjournment.

Present—Counsel as before.

CROSS-EXAMINATION of Mr. AYLSWORTH continued.

*xQ.* 123. In answer to question 8, you speak of the property of the composition containing carnauba, namely that after being cast, it does not shrink perceptibly until it is solid and comparatively cooled, etc. Is this a property of carnauba when existing alone, as well as of the composition containing carnauba?

*A.* The carnauba alone would be impossible to cast successfully into a record, on account of its excessive contraction and warping. Carnauba wax when solidifying, shrinks to such a large extent that fissures and cracks are formed in all directions. Especially is this true when it is suddenly solidified. I would expect that a mixture of carnauba wax and the blank composition, if the carnauba is used in considerable percentage, would develop extraordinary properties of shrinkage and that such mixture might develop unfavorably for the purpose of casting the records. But, however, in experimenting it was found that the combination of carnauba and the blank mixture gave a most favorable result, and did not exhibit any of the extreme properties of shrinkage, which are inherent in the carnauba wax alone.

*xQ.* 124. You evidently misunderstand my question and perhaps I have misunderstood your direct deposition. Am I correct in saying that in casting records from the composition of the patent in suit, the molten composition does not contract at a uniform rate continuously from the very moment heat is removed to the end; but remains in contact with the mold until it has become comparatively cool and solid, and thereafter shrinks radially sufficiently to clear the matrix-surface?

*A.* What takes place in casting a record from the composition of the patent in suit is as follows:

The molten material is chilled and solidifies on the surface of the mold, which is accomplished by either dipping the mold maintained at a relatively lower temperature than the composition, or by filling the mold with the molten composition and allowing the mold to come to the temperature of the composition, and then subsequently performing the congealing operation, by the application of cooling agents to the exterior of the mold, in both cases there results a solidified layer of the composition on the inner surface of the mold, which remains in contact with the mold and does not shrink therefrom until the solidity reaches a certain stage. Shrinkage, however, does take place from the time the wax first begins to solidify, but such shrinkage does not result in the shrinkage of the solidified material from the mold, but such shrinkage takes place in other directions. In the case of the dipped record before mentioned, this shrinkage takes place from the hot and more plastic inner surface of the cylinder toward the mold, that is, radially outwards. And, in the case of casting the record, whereby the mold is filled with the molten material, the first shrinkage takes place also from the inner surface of the cylinder radially towards the mold. Then, in both cases, when the inner part has solidified to such a point that it tends to resist its radial outward shrinkage, the record begins to shrink away from the mold.

*xQ.* 125. That is very clear to me now, and it applies to the composition of the patent in suit, which contains carnauba. Now, disregarding the character of the mold, and disregarding whether or not you will get a good sound record from carnauba, without any other materials added, will molten carnauba by itself behave the same way after shrinkage if treated by either of the two methods you have just set out?

*A.* I do not think that carnauba by itself will follow the exact phenomena of shrinkage which the blank composition and the patent in suit displays. As I stated before, I have always found it impossible to cast a record of the pure carnauba and unless that were done, it would be impossible to state just what would take place.

*xQ.* 126. If the blank composition by which I understand you to mean the composition of the patent in suit minus the carnauba and lamp black, be treated in either of the two manners set out in your answer to *xQ.* 124, will it behave the same way as the composition of the patent in suit, as regards its shrinkage?

*A.* The blank composition in its phenomena of shrinkage is similar to the composition of the patent in suit. By shrinkage, I mean shrinkage from the mold in casting or molding records. But there are slight differences in this, which as I have before testified, result in quite marked differences as to the surfac of the product. This I attribute to the fact that the composition of the patent in suit remains in contact with the mold longer, so that when it does shrink from the mold it is cooler and somewhat more coherent, which results in a cleaner molded surface.

*xQ.* 127. Why does the composition of the patent in suit remain in contact with the mold longer than the blank composition?

*A.* Just exactly why the composition of the patent in suit remains in contact with the mold longer, there is no absolute proof, but I attribute the phenomena as being connected in some way with the formation of the esters that result from the reactions of the carnauba with the wax composition.

*xQ.* 128. So far as you know, is there any wax composition to which a substantial amount (say 15%) of carnauba wax can be added, where the resulting composition will not present the same phenomena with regard to shrinkage as with the case of the patented composition? And, I am asking about the shrinkage only and not about the resultant sound record or other article.

*A.* Yes, there are many such compositions that will result in differences in shrinkage; for instance, a composition of stearate of lead, which is a wax-like material, when mixed with carnauba has the property of such excessive shrinkage that it leaves the mold before the finishing operation can be performed and before the major part of the shrinkage has taken place. A mixture of carnauba, wax and asphalt, on the other hand, leaves the mold much slower, and in fact it is very difficult to remove a record cast with carnauba and asphalt in the proportions mentioned in your question. In the first case, which I cited, there is so much shrinkage takes place after the record leaves the mold that the indentations become very much blurred or rendered less sharp than those of the matrix.

*xQ*. 129. In *xQ*. 124, you name two methods of casting records, of which I understand the first to be that practiced by you in making the records from compositions "B," "C," "D" and "E" as set up in your direct deposition, is the second method named by you in *xQ*. 124, substantially that disclosed in Defendant's Exhibits "Macdonald Reissue patents 12,095 and 12,096" of March 10, 1903?

*A*. Yes, the method used in casting these compositions was the same as described in the first part of my answer to *xQ*. 124, and the second method described is similar to the method disclosed in Macdonald patent No. 12095 reissue: in both cases, however, the results as to shrinkage take place in the same manner; that is to say, as far as the casting of the record is concerned the shrinkage must take place in the same manner.

*xQ*. 130. The Macdonald reissue patent No. 12095 aforesaid, about line 77, of page 1, directs the application of cold water to the outside of the matrix. If the matrix contains your ordinary blank composition, or what I term the "Macdonald composition," what effect would this external application of cold water have upon the outer surface or rather upon the particles of the molten composition that are in contact and those immediately adjacent to the matrix-surface?

*A*. The application of cold water as you have described in your question would tend to produce a more amorphous layer of the same composition.

*xQ*. 131. What effect would this applicaton of cold water upon the exterior convex surface have upon the consistency of that portion of the molten composition that is adjacent to the matrix-surface, that is as regards fluidity or becoming solid, etc.?

*A*. The application of cold water, as you have described in the question would result in solidifying the molten material onto the surface of the mold, and such solidification would proceed throughout the mass of the material.

*xQ*. 132. Would the mass of the material, that is the portion located nearest the axis as distinguished from the portion of the blank composition that is adjacent to the matrix-surface, would that mass meantime be contracting or shrinking radially outward towards the portion already solidified by the application of the cold water?

*A.* Yes, it would continue to shrink radially towards the inner surface of the mold after it had solidified in its first stages, wherein it is very plastic.

*xQ.* 133. If instead of adding carnauba to your blank composition to obtain the specific composition set out in your patent, you should add Bees' wax, would the resulting composition, if cast, by the dripping process, as described by you, behave in the same manner as to shrinkage as the carnauba composition?

*A.* The shrinkage phenomena would be similar, but, of course, in the case of bees' wax the proportions would have to be smaller than in the case of carnauba to get relatively similar results in the composition.

*xQ.* 134. Why would you have to use less bees' wax to get relatively similar results in the composition?

*A.* Bees' wax toughens the composition, but if added in as large a percentage as the carnauba, I think on account of its more sticky nature it would be not so satisfactory.

*xQ.* 135. It seems then that if we employ bees' wax instead of carnauba in the patented composition, we have to take less bees' wax. What effect would this smaller amount of bees' wax have upon the composition with regard to limpidity, smoothness of texture and brilliancy of surface and hardness?

*A.* It would have all of the desirable effects of the carnauba.

*xQ.* 136. Would this smaller amount of bees' wax render the blank composition harder?

*A.* It would render the blank composition harder in the sense that the records would wear better than the blank composition without the bees' wax. The high price of bees' wax, however, has rendered it unnecessary for us to go into the merits of this substance very extensively.

*xQ.* 137. Do you regard bees' wax as a hardening ingredient for the blank composition; and if so, why did you not include it in the list given in answer to *Q.* 39?

*A.* I regard bees' wax as being a hardening substance if used in small quantities, in that it toughens the material, so as to produce a better wearing surface. It is, however, in itself not a hard substance in comparison with carnauba wax. As to why bees' wax was not mentioned in the list you refer to, that list does not attempt to include all of such substances, and bees' wax is one of the substances that has been overlooked in making out this list.

*xQ.* 138. In answering *Q.* 16, you state that the foggy appearance or roughness, which you observe as characteristic of the records you "dipped" from the ordinary blank composition, was present in the records dipped from your patented composition ("E") in a few instances only. How do you account for this roughness or fogginess in those few instances where you employéd the patented carnauba composition and the dipping process?

*A.* They might have been due to the molds not being perfectly clean, and I think that explanation accounts for it, because in our regular manufacture of this composition, there is very seldom any of this foggy effect.

*xQ.* 139. Your explanation is a conjecture, is it not?

*A.* The explanation is founded on observation, but as regards this particular instance, I did not investigate it so as to determine with exactness that such was the case.

*xQ.* 140. You have explained the absence of fogginess in the records dipped from the carnauba composition, by stating that the material does not leave the matrix-surface until it has already become solid and set, so that it retains a sharper and more faithful impression. In answer to *xQs.* 131-132, you say that if we employ your blank composition and apply cold water to the exterior of the mold, the composition in that case will become solidified onto the surface of the mold, and the mass of the composition would in the meantime continue to shrink radially towards the surface of the mold, after it had solidified in the first stages. And, in answer to *Q.* 6, you have said that the surface of the ordinary blank composition is "very smooth." Are all these statements true and correctly stated by me; and if so, could you not obtain from the ordinary blank composition by applying cold water to the exterior of the cylinder, sound records whose surface would be free from cloudiness and fogginess?

*A.* I have not practiced the exact method which would be involved in your question of subjecting the mold to cold water, but it is my opinion that if such procedure did accomplish the result of making the surface free from fogginess and a perfectly smooth surface, that the application of such excessive cooling would result in stresses in the record which would cause excessive warpage and possibly breakage.

> Mr. Massie—All after "cold water" objected to as incompetent and as volunteered.

*xQ.* 141. By "runout," one of the headings in your table in answer to *Q.* 60, do you mean that the record groove itself has not been retained in the cylinder; or do you mean something else, and if the latter, what?

*A.* By "runout" I mean a distorted groove, due to warpage; this may come from the record coming loose from the mold first on one side, and then later, from the other side, which causes the effect of one side being contracted more than the other side, and this leaves the record groove somewhat curved or out of its true course.

*xQ.* 142. That is, instead of the successive convolutions of the record-groove constituting a perfect helix, with the same distance between the convolutions, some of the latter are shifted longitudinally of the cylinder, and lie too near to (or to far away from) the next convolution?

*A.* Not exactly; the effect would be more that of having on one part of the record, say 100 threads to the inch, and on another part of the record, say 99 threads to the inch, also various distortions, such as might be illustrated by the grain in a piece of wood.

*xQ.* 143. How many of the 56 records noted at the end of Q. 60 as being "Not Round and Run Out" were run out only, how many were "not round" only, and how many were subject to both conditions?

*A.* It is my recollection that they were approximately equal, although, in many cases both defects were noticed in the same record. These defects are so co-related that they were put under one heading, but if desired the number due to each effect can be produced.

*xQ.* 144. If you can do, I would like the figures; and also the corresponding figures for the 23 of Formula "C," the 35 of Formula "D" and the 40 of Formula "E," that were observed to be "Not round and run out"?

*A.* I will produce these at the next session.

*xQ.* 145. Is the fact that more or less specimens from each of the four compositions were "cracked and broken," or had "Chipped Edges," or were "Broken in Handling" indicative of any difference in the limpidity of the respective compositions when molten?

*A.* No, these defects are more indicative of the brittleness of the composition, but as I have before testified those figures do not represent with mathematical exactness the brittleness of the composition, because in operations of this kind the product is handled during the various stages by different operators, but they are a very fair indication of brittleness, and if many thousand were made, whereby the human element would be averaged so as to become negligible, it would indicate with almost mathematical certainty the more or less brittle nature of one composition over the other.

All but the word "No" objected to as volunteered.

*xQ.* 146. Are the facts recited in the previous question indicative of the presence of more deleterious decomposition products in one material than in the other?

*A.* If there were present in the composition, deleterious substances which would cause brittleness more in one instance than in another, then these results would be indicative of more deleterious substances in one case than in the other.

Answer objected to as not responsive.

*xQ.* 147. Are the facts referred to in *xQ.* 145 indicative that any of the four materials has a finer texture or a smoother surface than any other or others of the four?

*A.* If the fine texture is indicative of increased strength of the material, which I believe to be the case, these results would be indicative that there was a finer texture in one case than in another. As to the latter part of your question regarding the surface, these results would indicate nothing as to the surface of the material.

*xQ.* 148. That is, the figures enquired of in *xQ.* 145, do not indicate that the records from one material are more free from fogginess than those from any other?

*A.* As I have stated in my previous answer, the surface of the material would have no effect on the number of records "Cracked and Broken" or "Chipped Edges."

*xQ.* 149. Do the facts referred to in *xQ.* 145 give any indication that one material is more hygroscopic than the other?

*A.* The facts referred to have no bearing on the hygroscopic nature of the material.

*xQ.* 150. The figures under the headings referred to are to be attributed solely to the personal equation of the various workmen handling the article, and to the relative toughness and brittleness of the respective compositions?

*A.* The figures given in those columns, I should say represented in a large measure the comparative brittleness of the various compositions, but that on account of the human error they do not indicate this with mathematical certainty; that is to say, one composition might have a few more records broken accidentally in handling than would affect the results slightly.

*xQ.* 151. Of the 93 records dipped from composition "B," 18 were subject to the objections enquired of in *xQ.* 145. How many of these mishaps were due to careless handling alone, how many were due to their inherent brittleness or want of toughness alone, or how many were due to both factors?

*A*. In the composition "B" I know that two out of the 18 were broken in handling, but as to the number in this composition and in the other compositions aside from these two mentioned that were broken, due to accident or handling, no record of the breakage due to handling as distinguished from that due to the brittleness of the composition was kept. The operators, however, who did the work on these records handled them all very carefully and the percentage due to accidental causes was in each case extremely small.

*xQ*. 152. I notice of the 93 records of Composition "B," 16 whose defects were not due exclusively and explicitly to careless handling, that is about 17% were cracked and broken or chipped; and in the same way there were 14 of the 86 records of composition "E," or 16% about. Would you assume from this that composition "B" was about of the same toughness or non-brittleness as composition "E"?

*A*. While I have not figured the percentages indicated in your question, they appear to be about right and as to the brittleness would indicate that the composition "B" and composition "E" were about equal in this respect.

*xQ*. 153. Composition "D," which you have taken as being substantially defendant's composition, shows 26 losses out of 95 records, or about 27% (as against 16% and 17% for "B" and "E"), although composition "D" contains both ceresin and carnauba in substantial quantities. Do you conclude from this that the toughness or non-brittleness of the patented composition is to the same quality of defendant's composition as 27% is to 16%?

Adjourned to Tuesday, February 26th, at 10 A. M.

ORANGE, N. J., Feb. 26, 1907.

Met pursuant to adjournment.

Present—Counsel as before.

CROSS-EXAMINATION of Mr. AYLSWORTH continued.

By Mr. Dyer—Counsel for defendant is informed that the matter called for in *xQ*. 143 and *xQ*. 144 will be produced in connection with the depositions of other witnesses by whom the figures and calculations were made.

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By Mr. Massie—Am I correct in understanding that all the figures given in the table in the answer to *Q.* 60 were given to the witness by other parties, and so far as this witness is concerned is secondary evidence.

By Mr. Dyer—Counsel for complainant suggests that the information can be obtained from the witness, rather than from counsel.

*xQ.* 154. I call your attention to the table appearing at the end of your answer to *Q.* 60. Please indicate which of these figures are given of your own knowledge and are not merely reports given to you by the various inspectors?

*A.* The figures given in this table were taken from the inspectors' reports, who inspected these records without any instructions as to what they were, but were told to give them the regular inspection, such as they give the regular work in their respective departments. These inspectors are skilled in this line of work and follow it daily. I personally witnessed the inspection as regards the first four columns, but those of the fifth column, namely "not round and run out," which were done in Mr. Payne's Department were not personally witnessed by me. I will here state, however, that the items of this column are usually inspected by Mr. Sturms, though not so strict an inspection is practiced in his department and since we had decided to give these records the final master inspection, the matter of "not round and run out" was omitted in Mr. Sturms' inspection. The results of the first inspection were gone over very carefully by Mr. Holden and myself; that is, we examined the discarded records to see the defects. I also examined some of the discarded records under the column of "not round and run out" and satisfied myself with the correctness of the inspection.

*xQ.* 155. Will you please answer *xQ.* 153, which is now shown you?

*A.* In regard to this comparison which you have stated in *xQ.* 153, the apparently abnormal percentages shown between compositions "D" and "E," I should say were not altogether in this instance due to the brittleness of the composition, but rather accidental. The results of the figures, however, taken as a whole comparatively are additional proof to me of the properties of these compositions which I know from long experience differ in their physical properties as to brittleness; that is, from other experiments which I have made in the past and physical tests to which I have subjected these compositions, that these figures are all in agreement with each other as to the differences in these compositions.

*xQ*. 156. I understand from your answer to *xQ*. 154 that the results of the first four columns were gone over very carefully by you, to the extent that you examined the discarded records to see the defects. Did you likewise examine all of the records of the four compositions that were not discarded in order to see whether any of these might show defects?

*A*. Yes, I looked over the finished or perfect records as well as the discards, and the further correctness of the inspection was checked by the second or final inspection in Mr. Payne's department.

*xQ*. 157. Did you take part in that second or final inspection?

*A*. I examined some of the records to satisfy myself of the correctness of the inspection, but did not take part in the actual inspection.

> Reference to the second inspection is objected to as hearsay and incompetent.
>
> Reserving for the present the right to object to the table in question as being secondary evidence until after the inspectors have testified, defendant's counsel now objects to the said table as untrustworthy and misleading, because it does not appear what number of discarded records of each kind were defective on account of causes not inherent in the compositions.
>
> Pending the introduction of the figures distinguishing between "Run out and not round," defendant's counsel will have to withhold further examination on the tests made by this witness.

*xQ*. 158. Will you please describe what you did in making the limpidity tests referred to in answer to *Q*. 4, telling us for instance, which composition you tested first, how you made the observations, how long it took in each case, size and dimensions of the funnel, etc.?

*A*. I do not have the figures for the size of the funnel which you call for in your question, but will produce the funnel which I used for your examination. What was done was the following:

About 8 lbs. were melted in a pot by the aid of a gas burner having very careful regulation, so that the temperatures could be maintained at the desired point. The experiments were made jointly by Mr. Holden and myself; Mr. Holden doing the timing by a watch, and I called the time of starting and time of finishing in each instance. In doing this the funnel was first submerged in the molten composition sufficient time for it to become heated to the temperature of the composition, then lifted out quickly and emptied by inverting, and then placed so it would float on the composition, and the exact instant when it floated was called off to Mr. Holden, and the exact instant when the funnel disappeared below the surface was called off to Mr. Holden. The composition first tested was composition "D." These experiments were made with these compositions at two temperatures; that is, a temperature not far above its melting point, and at a temperature considerably higher than the melting point, so as to get the fluidity at different temperatures.

*xQ.* 159. The tables of this test which you have just handed me showing the different temperatures and elapsed times, from which you have taken the averages, show do they not, that there is no absolute relation, in specific instances, between the temperature and the time required for the funnel to sink; that is, for instance, with the first three tests with composition "D," at the same temperature you get three different time periods, 1 minute and 9 seconds, 1 minute and 24 seconds, and 1 minute and 11 seconds respectively,—though all were at supposedly the same temperature?

*A.* In making determinations of this kind, it is not like working with an instrument of precision, such as a micrometer, and there are, of course, small differences in the results, to overcome the effect of which a sufficiently large number were tried to strike a fair average. The results are on a whole more concordant and exact than I believed was possible. The average results I consider to be absolutely accurate criterions of the fluidity of the compositions at the average temperature of the experiments in each case. It was my intention to make these experiments more extended before these tables were introduced. The results are, of course, comparable with each other, but I expected to make a further test with the same apparatus with other fluid so as to further compare the fluidity of these compositions with, for instance, water as a standard.

*xQ.* 160. There has been some discussion as to whether it is toughness or hardness or both, that causes the cast records to wear longer; and there is some question also as to whether or not the continuing high temperature produces a chemical reaction; and concerning the effect of the continued high temperature in eliminating deleterious decomposition products. But you agree with us, do you not, that whatever names be given and whatever scientific explanation is offered, if a substantial amount (say 15%) of carnauba wax be added to your ordinary blank composition (which we called "the Macdonald Composition") and a comparatively high temperature (say 450° F.) be mantained for a considerable time (say four or five hours), we get a composition that is free from deleterious decomposition products; and we get a composition from which we can cast records that will wear longer, under reproduction on a phonograph, than records cast from the ordinary blank composition aforesaid?

*A.* As to whether the composition you have described containing about 15% of carnauba, heated to a high temperature, say 4 or 5 hours, is entirely free from decomposition products, depends more on the selection of the materials and their proper filtration, and does not follow entirely from the method of making the composition, wherein the high temperature is maintained for the time specified. I agree that such composition has the properties of wearing better than the blank composition. I furthermore know with absolute certainty that the property of better wearing is not due to the simple heating of the composition to the high temperature for the time mentioned, wherein there are no reactions such as we know take place in the composition containing carnauba, for the reason that the blank composition, when so heated without the carnauba does not produce the result of good wearing.

*xQ.* 161. If I add to the questioning part of *xQ.* 160 the condition that all materials have been selected with the utmost care, that they have been purified as far as as it is possible to do so, and that the resulting composition is filtered with utmost care, then will you agree to the proposition that we get a composition that is practically free from deleterious bodies, and that records made by casting therefrom will wear longer than those made from the regular blank composition?

*A.* If the compositions are made with materials that are selected with the utmost care, I would consider that the compositions would be free from deleterious substances but whether they are free from deleterious substances or not would have very little effect on the wear of these two compositions; that is, in every case in which I have experimented with the carnauba composition in comparison with the blank composition, the wearing of the composition containing the carnauba has shown up very much more favorably, no matter whether it was a rough experiment wherein the materials were not particularly selected as to freedom from deleterious substances, or not.

*xQ.* 162. Is your answer to *xQ.* 161 "Yes;" do you answer the question in the affirmative?

*A.* I think your question calls for an explanatory answer, such as I have already given, and could not be answered by simply yes or no.

*xQ.* 163. I will divide the same inquiry into two portions. And first, can you say yes or no to this question; If we exercise the greatest care in selecting the materials, and if we resort to filtration with the greatest care, and if we add to your ordinary blank composition about 15% of carnauba wax, and maintain the mixture at a temperature of about 450° for four or five hours, will the resulting composition be free from deleterious bodies? Can you answer this question yes or no?

*A.* If we select all of the materials with a view of eliminating deleterious substances, I think that the resulting composition would be free from such substances unless the products of reactions might develop something injurious which to my knowledge does not occur; that is, does not occur and leave any delterious substance in the finished composition.

*xQ.* 164. It seems to me that you have gone out of your way to add to the conditions stated by me, another condition which to your knowledge is not present. Can you not answer the question yes or no?

*A.* I cannot answer with such a positive answer as yes to this question, for the reason that absolute freedom from such deleterious substances would be impossible to attain. No matter what care were taken in the selection of the materials there is the possibility of some traces of objectionable substances being in the material, but I should say that it would be practically free from deleterious substances if such care as you mention in your question were taken.

*xQ.* 165. Then, for all practical purposes and speaking practically, your answer to *xQ.* 163 is in the affirmative?

*A.* In the practical sense, I think that is correct.

*xQ.* 166. Second, would records molded from the composition made of the materials and in the manner stated in the *xQs.* 160-164, be more durable under the wear tests, than the records made from the ordinary blank composition? Can you answer this question yes or no?

*A.* If I understand your question correctly you ask whether or not the composition containing carnauba wax and heated to a temperature of 450° for four or five hours, in other words, the composition of the patent in suit, is more durable as to wear tests than the blank composition. My answer to this under the above interpretation of the question is most positively, yes.

*xQ.* 167. You have correctly understood the question. I will now combine the two inquiries as in *xQ.* 160: If you take the materials indicated in *xQs.* 160-164, and treat them as indicated in the same *xQs.* will the resulting composition be practically free from deleterious products of decomposition, and will the records molded therefrom be more durable under the wear-tests? Can you answer this question yes or no?

*A.* Assuming that the reactions between the carnauba wax and the material of the blank composition are entirely completed, I should answer in the affirmative.

> Answer objected to as not responsive, since it assumes that "reactions" are taking place, whereas the original question (*xQ.* 160) is neutral as to such assumption.

*xQ.* 168. If instead of saying that the high temperature is maintained for four or five hours, we make the question more specific and say that the high temperature is maintained until all foaming off or frothing of the carnauba composition has ceased, then can you answer *xQ.* 167 in the affirmative?

*A.* Your amended question, substitutes a part of the evidence of reaction and is otherwise the same as the first question, and consequently my answer would be the same, that is, yes.

*xQ.* 169. Is complainant's exhibit, Early Columbia Molded Record, one whose record-groove has "run out" as that term has been used by you?

*A.* I have not examined the particular record of which you speak, as to how much of the record-groove is run out, but I can very soon determine this point by trying this record on a phonograph.

*xQ.* 170. I understand your testimony to be that this particular record is "not round." Will you please be good enough to test this exhibit on a phonograph and report whether or not its record-groove is "run out."

> At this point a recess was taken for the purpose of enabling the witness to make a test of the record in the presence of counsel for both parties, as requested in the preceding question. The witness continues his answer to the question.

*A.* Upon testing this record in the presence of counsel, I find this to be a most characteristic example of both "out of round" and "run out." Such a record as this one would be of no commercial value at the present day.

*xQ.* 171. Do I understand that the various records noted in your table at the close of your answer to *Q.* 60 as being not round and run out, were as an average no more so than this particular record, "Complainant's Exhibit, Early Columbia Molded Record"?

*A*. It is my recollection that some of the records made of the blank composition were even worse than this one, but with the other compositions mentioned in the table where they were discarded for "not round" and "run out" they were not as bad as this one.

*xQ*. 172. Do you observe on this article "Complainant's Exhibit, Early Columbia Molded Records" any indications of deterioration, due to hygroscopicity?

*A*. I observe on this record by holding it in the light a damaged surface, but whether it is due to hygroscopicity or not, I cannot state off-hand. This record has been kept in a carton box, which would of course protect it from damage due to hygroscopicity, even if it were prone to such an effect.

*xQ*. 173. Do you observe on this same exhibit any other indication of any break-down of the material, efflourescence, moldiness, or similar injury?

*A*. I observe whitish streaks in the record-groove, which has the appearance of an imperfectly molded surface, but not that of moldiness or hygroscopicity.

*xQ*. 174. These "whitish streaks in the record-groove" I do not seem able to detect with my eyes; they are not very conspicuous, are they?

*A*. When held in the sunlight at the right angle they are quite conspicuous.

*xQ*. 175. Was this record played, that is reproduced, throughout, from end to end, in the test made just after *xQ*. 170?

*A*. It was, but I noticed this same appearance before the test was made. In fact, playing a record over would not make the effect noted. In a wear test a breaking-down of the record is noticed, but it gives a different appearance from this.

*xQ*. 176. In listening to the reproduction of this exhibit record just now, did you observe whether or not the machine failed to reproduce the selection, or at any portion of the selection?

*A*. I did not notice that the machine failed to reproduce the record, but I did notice that the reproduction was very imperfect and rough. Such a record would find very few customers today; that is to say, in the present state of the phonograph art.

*xQ*. 177. What do you mean by "imperfect and rough?"

*A*. I mean by "rough," a comparatively rough surface which produces foreign noises, which do not form a part of the sound record. By "imperfect," I mean the wobbly or jerky sound, due to the irregular or non-concentric cylinder, which is undoubtedly caused by the distorted record-groove.

*xQ.* 178. Is it your testimony that the reproduction of this selection sounded wobbly to you?

*A.* Yes, I could tell from listening to the record without seeing it that the record was one of the kind which we call "run out."

*xQ.* 179. Is the "roughness" that you say you observe, due to the "not roundness" and the "run outness;" or would you attribute it rather to the nature of the composition, the condition of the mold in which the record was made and the manner of making the record?

*A.* I would consider the roughness noted as being caused by inferior molding properties of the composition, in other respects than the defects due to warpage.

*xQ.* 180. Was the test following *xQ.* 170, made on a regular phonograph?

*A.* It was made on a regular phonograph supplied with a regular reproducer, supported not by the regular arm, but so arranged that the reproducer could move and adapt itself to wide eccentricities and indicate the same by a pointer fastened thereto. This instrument is what we call our regular thread testing instrument, and while indicating defects due to shrinkage, it also reproduces the record in the same manner as the regular phonograph.

*xQ* 181. What sort of a horn did you use?

*A.* There was no horn used in this test, the defects were sufficinetly marked to be audible without the magnifying aid of a horn.

*xQ.* 182. The "pointer" fastened to the reproducer was some six or eight inches long, was it not?

*A.* The pointer was about six inches long and made of a very light strip of bamboo, and being flexible it does not move as a whole with each sound vibration, but only indicates the large irregularities, amounting to a large fraction of the circumference of the record-groove. This instrument exerts such light pressure on the record that master records from which molds are made can be tested on it without injury to the same. By "master records" I mean molded masters, from which additional molds are made.

*xQ.* 183. Does the moving or the mere flexing of this pointer tend to any extent to "dampen" or retard the movements of the reproducing-stylus?

*A.* It may have some slight dampening effect.

*xQ.* 184. What effect would this dampening effect have upon the audible reproduction?

*A.* If there were no irregularities such as would cause the needle to violently fluctuate, it would not cause any notable effect in the reproduction of the sound; that is to say, if the records were perfectly round, the reproduction would not sound wobbly with this instrument.

*xQ.* 185. The question is repeated.

*A.* The sounds would not be as loud and clear.

*xQ.* 186. Are you uncertain in your own mind whether it is the carnauba or the lamp black, which, in your opinion, imparts antiseptic properties to the composition? (*Q.* 31.)

*A.* Yes, I do not know positively whether this property is due to the carnauba or the lamp black, as no specific experiments were tried to determine this point, but the observation is based on the lack of complaints with the composition containing carnauba. In other words, we have had no complaints from this cause since using this composition. I should, however, after due consideration of my recollection of what was done in the early stages of the manufacture of the molded records and the carnauba composition conclude that the carnauba ingredient was chiefly contributory to this effect, because in the earlier records that were put on the market, the lamp black ingredient was not used. The material in this case was colored black by crude ozokerite.

*xQ.* 187. If your conclusion be correct would it not follow that whenever carnauba is combined with these wax-like phonograph compositions, it imparts more or less of its antiseptic properties?

*A.* Yes, I would conclude that it would contribute these effects, but not having tried it specifically, of course, I could not make a positive answer. Of course, the materials or compositions, which were put on the market were those made according to the patent in suit, and the properties noted might be contributed by the reactions which take place in making a composition.

*xQ.* 188. So that if it should prove to be the fact that no reactions take place to any appreciable degree in making the composition of the patent in suit, your present conclusions are to that extent to be thrown out?

*A.* If such a condition were proved I would, of course, alter my conclusion on this particular question of antiseptic properties.

*xQ.* 189. In one of the companion suits, on Macdonald patent No. 606,725, I think, in which the Graphophone Company is complainant, my recollection is that in testifying about records made from the composition which you are now terming your record blank composition, you stated that in the beginning, there were complaints that these records were developing signs of mildew or mold; that you visited the customer or customers who made such complaints and found that they were keeping your records in damp cellars; that you instructed the parties not to do this; and that thereafter there were no further complaints on this score regarding the records put out by your company of that old composition? I have not now before me the testimony in question; but would ask you if the foregoing questions are correct?

*A.* I recollect the testimony to which you refer and the particular customer referred to was a concern in Easton, Pennsylvania. There were many other complaints but they were scattered here and there all over the world. Some of the most serious specimens of this complaint I recollect came from Bombay, India. However, the disappearance of the complaints due to this defect came at the time the new records of the patented composition were put on the market.

*xQ.* 190. That is to say, the former composition developed by you and which your company was using during the early nineties and before your carnauba composition was developed, whatever that earlier composition was, would not keep without mildewing unless great precautions were taken?

*A.* No, that is not exactly right. The mildew effects would take place with those earlier compositions if such compositions were exposed to the germs and influences and surroundings which cause mildew to develop. Many records made from those compositions and without any special effort to protect them were kept for a long period of time without developing the mildew effect. As a matter of fact this mildew effect was only produced in certain localities where the temperature conditions and contributory causes existed.

*xQ.* 191. Was it evident a priori before you produced your patented carnauba composition, that sand, sawdust, plaster-of-Paris etc., if added to your regular blank composition would render the surface of the composition unduly rough?

*A.* It is not at all apparent what the effect of a mixture of such substance would have in a *molded* record, without first trying the experiment. If we were dealing with a blank composition, however, it would be very apparent that such admixtures would be undesirable.

*xQ.* 192. That is, when you set out to develop your patented carnauba composition, you did not even have so much as a guess that the presence of sand in that composition would tend to render its surface rough?

*A*. Yes, I might have guessed that it would result in a rougher surface, but without trying the experiment I would not know and furthermore, I was endeavoring to not only secure a material that would be hard and smooth, but also one that would have the desired molding properties, and as to whether or not these substances would effect the molding properties favorably or otherwise would have to be determined by experiment.

*xQ*. 193. Do you not think that any man of ordinary intelligence, to say nothing about the persons "skilled in this art," would likewise guess that sand would render the surface of your regular blank composition rough; and would he not also guess that he could not melt the sand at the temperatures that these other materials can stand without being fused?

*A*. The man with ordinary intelligence might conclude that sand and sawdust would make a record rough, whereas, one skilled in the art might see and reason that the particles of sand or sawdust would not project beyond the surface of the groove of the record, and would on account of such reasoning try the experiments before discarding it. And, as to the effect of the melting of the same, of course, that would be obvious to any one who might experiment with such materials, that if sand were used it would be a mechanical mixture with the composition. However, the fact that it did not melt would not prevent one from trying it as a mere mechanical mixture.

Adjourned until Wednesday morning, February 27, 1907, 10 o'clock.

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ORANGE, N. J., February 27th, 1907, 1 P. M.

Met pursuant to adjournment.

Present—Counsel as before.

CROSS-EXAMINATION of Mr. AYLSWORTH continued.

*xQ*. 194. Before you developed your patented carnauba composition, was stearate of soda known to be hygroscopic?

*A*. Yes, stearate of soda was known to be hygroscopic.

*xQ*. 195. Was it known that asphalt, gutta percha, rosin, etc., did not have sufficient shrinkage as compared with the compositions suitable for molding records.

*A*. It was known that asphalt, rosin and gutta percha by themselves did not have sufficient shrinkage, as known by my experience.

*xQ*. 196. Do you believe that this information was known to other persons skilled in the art at that time?

*A.* I have no knowledge of what was known to other persons.

*xQ.* 197. What special advantages, if any, over prior compositions does your patented carnauba composition have as material for original phonographs, other than greater toughness or hardness?

*A.* I know that compositions containing carnauba were not as satisfactory as a recording or blank composition, for the reason that there was more scratchy noises in records made with the carnauba compositions.

*xQ.* 198. What advantages, if any, does your carnauba patented composition have over the other earlier compositions for making molded cylindrical records by the process of pressing?

*A.* I have not experimented with this composition using it by the method of molding by pressure, as stated in your question, and therefore can give no positive information of records made with this substance by that method.

*xQ.* 199. What advantages, if any, does your patented carnauba composition present in molding records by the process which is substantially set forth in the Macdonald reissue patents, 12,095 and 12,096, in which cold is applied to chill the casting from the exterior, other than greater wearing qualities?

*A.* While I have not cast records in the exact manner specified in the patents you refer to, the operations of this method are so nearly identical in principle and effect, with the methods practiced in the Miller and Aylsworth patent named in the patent in suit, that I believe the same advantages which I have found this composition to possess in the latter process, do also take place in the former process; and furthermore, from the character and appearance of the records which defendants in this suit first put upon the market, in which the defects noted in my previous testimony are apparent, that outside of wearing advantages, the advantages of molding with a more or less degree of freedom from undue warpage as compared to the blank composition is realized by the defendant when using the patented composition referred to in your question.

Reference to the "effect" of the process inquired of is objected to as incompetent, because the answer states that the witness has not practiced that process.

*xQ.* 200. What effect with regard to hardness or toughness would be produced if you employed stearic acid with your regular blank composition (with or without lamp black), in place of carnauba wax?

*A.* There is already present in the blank composition stearic acid in excess of that necessary to form a neutral compound with the basic constituents of the composition, and the effect of adding more stearic acid would possibly tend to harden the composition, but on account of its crystalline nature, and the lack of toughening qualities which my experience with mixtures containing more stearic acid; that is to say, considerable percentages more than already contained in the blank composition, while they would somewhat harden the composition, would not materially increase the wearing substance of the same.

*xQ.* 201. Did you try this experiment?

*A.* I have not tried the experiment of wear on the phonograph with that composition, but I have made such composition and it was so apparent from the way the material acted upon cutting with a penknife that it was considered unnecessary to try it further.

*xQ.* 202. Were you surprised at the results just referred to, or were these results more the nature of confirming what you had anticipated?

*A.* The results referred to came in the regular course of experimenting, and I do not remember that I was particularly surprised, or that I had anticipated the result. I would state right here that when one tries to anticipate the results of mixtures of organic substances he is pretty sure to miss the target in most cases.

*xQ.* 203. Am I correct in understanding that your work which led up to the developing of your patent carnauba composition consisted in a regular methodical examination and test of each and every ingredient and mixture of ingredients that seemed at all promising, applying to the same a similar, regular and methodical manner, all the various processes, (including temperatures) that occurred to you as being promising?

*A.* I think that my work was more or less methodical. I was after certain properties in the composition and did not allow myself to be guided altogether by theory as to the anticipated effects with the substances and mixtures that the same might produce, but rather allowed myself to be led by the actual results of experiments, and I know that in these experiments and in experimenting generally I frequently try mixtures and experiments which would seem more or less absurd, if the certain (i.e. already recognized) properties of the substances were to be considered as imparted to the results.

*xQ.* 204. As a matter of fact, after you had produced your carnauba composition, that is after it was patented, did you at once desist from further experimenting; or did you complete the range of examination that you had undertaken?

*A.* We considered this material to fill all the requirements and decided to adopt it as the regular composition for the reproduction, or rather for the molding of records, but, however, all experiments did not then cease; even up to the present time I occasionally experiment with, try and improve the record composition.

*xQ.* 205. Is your company still using the composition set forth in your patent in suit prepared in the manner therein described?

> Mr. Dyer—Question is objected to as improper cross-examination and the witness is instructed that he need not answer any questions tending to disclose factory operations or processes.
>
> Defendant's counsel considers the instructions just given to be pretty broad.

*A.* I refuse to answer under advice of counsel.

*xQ.* 206. When you first added carnauba wax to the composition described in the Macdonald patents No. 606,725 and No. 626,709, how much carnauba did you employ; what proportion?

*A.* I did not experiment with the composition of the Macdonald patent referred to in your question, but experimented with our regular blank composition, which is practically identical with the composition mentioned in the Macdonald patents, and which the Edison Phonograph Works had placed on the market many years before the applications for the Macdonald patents were filed. In these experiments I used our blank composition in combination with carnauba wax, both at the low temperatures, which it is usual to mix, and also in the manner disclosed in the patent in suit, in both of which cases, entirely new compositions were realized, and which had not to the best of my knowledge been made before. In these experiments the proportion was essentially that disclosed in the patent. I, however, experimented with different proportions and as a result of these experiments considered the proportions disclosed in the patents to be most desirable as to properties of the composition, aside from the matter of cost of the material.

*xQ.* 207. In the first part of your answer to *Q.* 41, you said it was difficult to mold even a blank from compositions which contained much carnauba. What percentage of carnauba did you there refer to?

*A.* The mixtures which I referred to in the answer to *Q.* 41

were mixtures of carnauba wax with ceresin and bees' wax and other natural waxes, and it is my recollection that when the percentage exceeded 20 per cent. that the difficulties were very great, but we were able to mold them, that is blanks, using as high as 30 per cent.

*xQ.* 208. Near the end of your answer to *Q.* 38, you say that (before you had produced the patented composition) you had been perfectly familiar with the properties of carnauba for more than ten years. What were the properties of carnauba which were at that period well-known to you?

*A.* That it one of the harder materials that is fusible and available for experiment, that it had very great shrinkage as compared with other hard substances such as shellac, rosin, copal gum, asphalt, etc.; that it was not miscible generally with every other substance, which I had available to experiment with; that it had the effect of communicating to such substances as it was miscible with, very excessive shrinkage and warpage; and also, that in a crude state it was more or less impure and contained particles of apparently powdered bark from trees and water, so that when melted it generally spit like grease when water is added to it for a short time until the water was expelled.

*xQ.* 209. Were these facts known generally at that time to persons skilled in the art?

*A.* I can only answer as to what I myself knew, but, however, the material was obtainable in the market and I would presume it would be known to others if they had experimented with it.

*xQ.* 210. What was the known method, if any, of purifying carnauba wax?

*A.* In the early days we purified it by melting to drive off the water and filtering. Later, however, when manufacturing the composition of the patent in suit, we first washed the material with boiling water, and then after decanting or separating the wash water from the wax which floated on top, we melted and boiled off what water remained and filtered the resultant wax.

*xQ.* 211. Without disclosing any matters of confidential nature, will you please explain how you became familiar with the properties of carnauba wax, during the past ten years or so; that is, for what purpose you were using it or experimenting with it?

*A.* Previous to the making of the composition of the patent in suit, my knowledge of carnauba wax was obtained by familiarity with the composition which was used by Mr. Edison in the early days of the phonograph for making blanks, upon which records were engraved by the cutting action of the stylus, and by my own experiments in the attempt to produce compositions for that purpose.

*xQ*. 212. Referring to your answer to *xQ*. 208, where you say that carnauba was not miscible generally with every other substance which you had available to experiment with, with what classes of substances was carnauba known to be miscible?

*A*. It was known to be miscible with the true waxes of similar nature to carnauba wax and with what is known as the true mineral waxes; there were, however, in the realm of wax-like substances, many substances which experiment had taught me that it was not miscible with others, such as certain asphalts, shellac and copal gum.

*xQ*. 213. What reasons, if any, had you to believe before you produced your patented carnauba composition, that carnauba wax would not be miscible with stearic acid? I mean, with commercially pure free stearic acid, that I understand consisted of mixtures of stearic and palmitic acid.

*A*. I had previously found out by experiment that carnauba wax was miscible with stearic acid.

*xQ*. 214. The first portion of the Aylsworth patent in suit contains a long enumeration of the qualities which the composition should possess. In connection with *xQ*. 203, I will now ask you if before you undertook the investigation which ultimately led to the production of your patented carnauba composition, you had already formulated more or less succintly, either mentally or otherwise, a list of these desirable qualities?

*A*. It is my recollection that I appreciated a part of the properties necessary in order to successfully cast a molded record, and that these views which I had on this subject were susceptible to change as developed by observation during the experiment. The one thing which I recollect was foremost in my mind as to the properties necessary was the molding property of the material. I had not been able previous to the discovery of this composition to mold any other composition successfully; that is as a molded record, although many attempts had been made with various substances, and I further recollect that it was only after making the composition that its superior wearing properties were found out. That is to say, that particular feature of the composition had not been forecast by me.

*xQ*. 215. Before you produced your patented carnauba composition, what reasons, if any, had you for supposing that carnauba (while imparting to the composition the desirable properties which it might be supposed to impart) would at the same time destroy or appreciably diminish other desirable properties which you deem essential for casting a sound record?

*A.* Knowledge of the extreme warpage and shrinkage of carnauba wax would and did cause serious doubts as to the utility of experimenting with carnauba wax for this purpose, and its desirable properties were rather the result of accident than observation in experimenting with carnauba wax in combination with the blank composition.

*xQ.* 216. That is, in your previous observation of the manner in which the carnauba wax without other ingredients would act on cooling?

*A.* That is the manner in which carnauba wax in combination with stearic acid and other materials, and also carnauba wax alone, acts on cooling, whereby phenomenal shrinkage is made apparent by warping and by cracks and fissures in the resulting composition.

*xQ.* 217. Than it is not true that the presence of carnauba wax in a composition with which it is miscible has the effect of materially reducnig any tendency to warping?

*A.* With the particular composition of the patent in suit, it does have the effect which is a contrary effect to what one would expect, having a knowledge of the abnormal shrinkage and warpage as referred to in my previous answer. In other words, it is true that the presence of the carnauba wax does act favorably towards undue warpage and shrinkage of the records cast or molded from the patented composition.

*xQ.* 218. If you take the ingredients named in your patent in suit, in the proportions there called for, except that the carnauba shall be 50% of the entire amount, and treat them in the manner described in your patent, what can you say as to your opinion of sound records cast by dipping from such composition?

*A.* That they could be successfully made, but there would not result sufficient improvement or advantage by the use of this relatively large percentage to warrant its use in the proportions mentioned.

*xQ.* 219. Suppose the composition be made in accordance with the process set forth in your patent, except that the carnauba employed be 50% or more of the entire composition, is it your opinion that if you undertake to cast records from this composition there would not be too much shrinkage or warpage?

*A.* It is my belief that if the materials were thoroughly combined in the manner indicated in the patent, that there would not be unfavorable shrinkage or warpage, and that the records could be successfully cast. I know from actual experience that considerably larger proportions of carnauba were used in some of my experiments and successful records were made therefrom.

*xQ.* 220. "Thoroughly combined," do you mean in the chemical sense?

*A.* Yes, I mean in the chemical sense, whereby the reactions mentioned in the patent are produced, with the resultant products of such reactions being formed.

*xQ.* 221. If you make a composition of the materials named in your patent and in the manner therein described, except that the carnauba shall be 3 or 4, or even 10 times as much as all the rest of the ingredients; do you believe that so far as shrinkage or warpage is concerned, you could successfully cast sound records therefrom?

*A.* I have never mixed carnauba with the composition in such great proportions as you mention in your question. Therefore, I cannot answer as to how such composition would behave when cast into a record.

*xQ.* 222. What is your best belief on the subject? I am asking only concerning warpage and shrinkage.

*A.* My best belief on this question would be that providing excess of stearic acid were present in sufficient quantities combined with myricyl alcohol of the carnauba wax, which may be either the free myricyl alcohol or which might be derived from the esters present as such in the carnauba wax, that even in the very great proportions, say, equal weight of each, or say 1½ parts the carnauba to one of the other ingredients, that there would result a composition capable of being molded and having the desirable properties in perhaps even greater degree than present in the patented composition. This however would be an uncommercial proposition on account of the relatively great expense of carnauba wax.

(Continuing answer to *xQ.* 222.) It is my belief, however, that if the proportions of the carnauba were continued higher, the point would be reached where its excessive shrinkage properties would manifest themselves.

*xQ.* 223. What percentage, if any, of free myricyl alcohol is present in carnauba wax?

*A.* The percentage of free myricyl alcohol present in carnauba wax is stated by Story-Maskyline to be 30% and this statement is confirmed by Sturke who made elaborate investigations of this material. This fact is substantially corroborated by the most recent investigators. So far as my personal observations are concerned; I believe that the carnauba wax contains a considerable proportion of free myricyl alcohol and while I have not experimented extensively to prove this point as yet, my observations of the reaction which takes place in making the patented composition, together with the finding of considerable proportions of stearic acid in the esters separated from the wax composition and the actyl number given by Lewkowitzch to my mind confirms this belief.

*xQ.* 224. I understand your answer to mean that in 100 lbs. of carnauba wax, there are present about 30 lbs. of myricyl alcohol. How many lbs. of free stearic acid would combine with 30 lbs. of myricyl alcohol under the proper temperature conditions?

*A.* I cannot answer this question without going into careful stiochiometrical calculations, and as this matter as well as the percentage of the myricyl alcohol present in the carnauba wax is now under investigation by me and others, I prefer not to answer questions along this line at this time.

*xQ.* 225. Disregarding warping, which I suppose we may consider as unsymmetrical shrinking, does the carnauba present in your patented composition—does the composition shrink more, or less, than the regular blank composition?

*A.* The composition if I correctly understand your question made from the patented composition does not shrink away from the mold as quick and at as high a temperature as was the case with the blank composition, and as this feature is very important in the quality of the record-surface produced, these results are of considerable importance.

RE-DIRECT EXAMINATION, by Mr. DYER:

*R-dQ.* 226. Can you state whether in connection with the patented composition as actually used it is necessary to vary the proportion of the ingredient and particularly the proportion of carnauba used, as variations take place in the climatic conditions, or because of change in seasons, or because of the localities in which the records may be used?

*A.* The composition is not altered for any of these reasons and is the same the year round. The records are sold all over the world and no complaints have made any changes necessary.

*R-dQ.* 227. Are you able to say of your own knowledge how extensive were the sales of records using the patented composition from February 1st, 1902, up to say—April, 1903, when defendant made preparations to change its composition?

*A.* The sales from the very first were very large, I should say, considerably over 10,000 per day, and from the beginning the sales rapidly grew to very much larger amounts. As to just how many were sold during the dates mentioned, if necessary, could be obtained from the books of the National Phonograph Company. I feel confident in stating, however, that the sales amounted to considerably over 10,000 a day for the period mentioned, which would amount to over 3,000,000. I have no connection with the selling department, but I kept a very close watch on the manufacture during that period and am quite positive that the amounts were even larger than I have stated.

*R-dQ.* 228. In answer to *Q.* 56, you state that when the present blank composition was developed by you, it made the Edison phonograph a much better machine than the graphophone, and that the latter was substantially displaced. When the graphophone again returned, did it still use the ozokerite blanks?

*A.* No, they used the composition identical with the Edison blank composition, and also the size and shape as the Edison blank, so that it was difficult to tell one from the other, even by analysis.

*R-dQ.* 229. In answer to *Q.* 46, you refer to the fact that the presence of lamp black would produce a rough surface. Is this true with the lamp black of the patented composition?

*A.* No, in the small proportions there used, there was no rough effect on the surface to be noticeable. In previous answer I had reference to sufficient lamp black to produce a hardening effect. If, however, lamp black is carefully selected as to fineness and free from gritty particles and lumps, a considerable proportion of it might be used without producing roughness on the records.

*R-dQ.* 230. Having reference to the table given at the end of your answer to *Q.* 60, kindly state what percentage of records of each composition was rejected because they were "Cracked and Broken," or had "Chipped Edges," or were "Broken in Handling"?

*A.* In the case of composition "B," 18 records were rejected for these causes, or 19.3 per cent. With composition "C,", 24 records out of 65 were rejected, or 36.9 per cent. With composition "D," 26 records out of 95 were rejected, or 27.3 per cent. With composition "E," 14 records out of 86 were rejected, of 16.2 per cent.

*R-dQ.* 231. Under the circumstances would these percentages indicate, perhaps not mathematically, but approximately, any peculiarity of the several compositions?

*A.* Yes, these percentages would indicate a greater brittleness of the composition "C" over all of the other compositions, which fact I know from extensive experiments with these compositions to be true outside of these figures. The composition "D" would appear from these figures to be more brittle than "E." I notice, however, that the composition "D" appears to be very much more brittle than "E," which I would nt expect to be the case. Outside of the abnormal percentage shown in "D," the general result of the figures are in exact accordance with what I know to be a fact.

*R-dQ.* 232. Suppose we eliminate entirely all discards mentioned in this table, except in the column of "Not round and Run Out," which I understand is indicative of warping or excessive shrinkage; what then would be the respective proportion of good records?

*A.* In the case of composition "B" under this assumption, 56 records would be rejected out of 70, or a percentage of 80 per cent. rejected, or 20 per cent. good. With composition "C," 23 records out of 33 would be rejected, a percentage of 69.6 per cent., leaving 30.4 per cent. good. With composition "D," 35 records out of 65 would be rejected, or 53.8 per cent., leaving 46.2 per cent. good. With composition "E" 40 out of 68 would be rejected, or 58.8 per cent., leaving 41.2 per cent. good.

*R-dQ.* 233. What general conclusion would you draw from these figures?

*A.* That the warpage and shrinkage of "B" was greater than "C," that "C" was greater than both "D" and "E"; the difference between the warpage of "B" and "D," for instance is about 27 per cent. I notice that the warpage as indicated in these figures in the case of "D" and 'E" is not materially different, one being 53.8 and the other 58.8 amounting to 5 per-cent., which is a variation that might naturaly be expected to occur, and does not necessarily indicate that one has more warpage than the other.

*R-dQ.* 234. Do these figures or do they not confirm your own practical experience with these compositions?

*A.* They do most decidedly confirm my own practical experience with these compositions.

*R-dQ.* 235. What composition do you refer to in answer to *xQ.* 211?

*A.* That is the composition used by Mr. Edison when I took up my first experiment that resulted in the present blank material. It was a mixture of ceresin and carnauba in the proportion of 70 of ceresin and 30 of carnauba.

*R-dQ.* 236. In answer to *xQ.* 160, you state: "I furthermore know with absolute certainty that the property of wearing better is not due to the simple heating of the composition," etc. What composition do you there refer to?

*A.* I there refer to a composition containing about 15% of carnauba, and the idea which I intend to convey was that if the high heat produced no chemical change it would not affect the wearing qualities of the composition, because I know from experience that when the blank compositioin was heated to a high temperature, its wearing qualities was not increased.

*R-dQ.* 237. If crude carnauba wax is added to the composition in the manner described in the patent in suit, would there be any difference in the resulting composition?

*A.* There would be no substantial difference in the resulting composition, excepting that it might contain particles of foreign matter like pieces of bark, and various dirt particles, which might prove objectionable.

Adjourned until Thursday, February 28th, 1907, 10 A. M.

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ORANGE, N. J., February 28, 1907.

Met pursuant to adjournment.

Present—Counsel as before.

RE-DIRECT EXAMINATION, by Mr. DYER, continued.

*R-dQ.* 238. In the manufacture of the blank composition, at what temperature do the chemical reactions take place?

*A.* From 250° F. to 320° F. chiefly at between 250° and the melting point of the wax, or rather the temperature at which the wax remains fluid, which is about 280°. The higher temperature of 320° results in a more rapid ebullition of the products of the reaction.

*R-dQ.* 239. Then, do I understand correctly that the blank composition can be perfectly made at no higher temperature than 320°?

*A.* Yes, in fact, the very finest material can be made at this temperature, it being very much lighter in color. In practice, however, for the purpose of hastening the operation, higher temperatures are used, and this light color is sacrificed, it being necessary of course, to take a very much longer time at the low temperature, than at the high temperature, and furthermore, it is difficult to always maintain the low temperature; that is not to exceed the low temperature of 320°. And in cases where the temperature does go higher, there results a darker material, which detracts from the uniformity of the product: that is to say, the uniformity in appearance of the blanks.

*R-dQ*. 240. And, as I understand it, in the manufacture of the patented composition, where it is desired to effect the chemical reactions between the carnauba wax, or its constituents and the stearic acid, a temperature above 400° is necessary?

*A*. That is correct.

*R-dQ*. 241. From your experience in this art, have you found that the action of the composition is affected by variations or changes in the methods of introducing the material within the mold, or in cooling the material after it has been introduced within the mold, or in effecting the removal of the material from the mold?

*A*. No, I have found from my experience in this art, during which many variations in the molding process have been tried, that a material which does not have the proper molding properties, exhibits them, no matter what the variation in molding may be. Of course, I don't mean to say that the molding method would not greatly effect the ability to mold at all, but a material that exhibits unusual warpage and shrinkage, will exhibit those features, and the consequent defects produced by the manner in which it shrinks from the mold, and the warpage which takes place then and after, no matter what the method of molding may be; that is, molding by a casting operation. Of course, this would not follow if molding by pressure, because in that case we would not realize the phenomena in passing from the molten to the solidified state. The same is also true as to brittleness and the wearing properties of the material.

*R-dQ*. 242.You state in your answer to *xQ*. 186 that: "In the earlier records that we put out on the market, the lamp black ingredient was not used." When did you begin to actually use this lamp black with composition?

*A*. With some of the records that were made in 1901, in order to build up a stock so as to have a supply on hand when we began to sell to the market on February 1st, 1902, instead of using lamp black I made use of ozokerite for the purpose of coloring the composition, but we used only a small amount of ozokerite, so that at least as early as February 1st, 1902, we were using the lamp black altogether. I find that altogether we made about 30,000 records using ozokerite as a coloring material.

Signature and certificate waived.

ORANGE, N. J., March 5, 1907.

JONAS W. AYLSWORTH (recalled).

DIRECT EXAMINATION, by Mr. DYER.

*Q.* 243. So far as the mechanical construction of the molded records made by the National Phonograph Company is concerned, have those records been changed in any respect since they were first put on the market on February 1st, 1902?

*A.* No, they have not, except that when the molded records were first put out the name of the selection was not molded on the end, as we now do. Otherwise, the records have been always the same. I might say, however, that because of some legal complication, for a few months last year the internal ribs were omitted, and the records were reamed out smooth on their bores, but we again returned to the rib. The drawing of the patent in suit, shows very clearly the form of record made by the National Phonograph Company. The Columbia records copy the same so closely that except for the name on them, it would be almost impossible to tell them apart.

*Q.* 244. Have you read the deposition of Mr. Cameron, defendant's patent expert in this case? *A.* I have.

*Q.* 245. Please consider the patents referred to by Mr. Cameron in answer to question 3, and state whether or not in your opinion these patents support the conclusions reached by Mr. Cameron in next to the last paragraph of that answer, and what, if any bearing, those conclusions if correct, may have on the specific art with which we are here dealing, namely, compositions for use in the manufacture of molded sound records?

*A.* In the answer to which you call my attention, Mr. Cameron refers to Tainter patents, Nos. 393,190 and 421,450, and to Edison patents Nos. 400,648, 430,274, 484,582, 484,583, and 488,191. He incidentally refers to Edison patent No. 200,521, to Bell & Tainter patent No. 341,214, and to Berliner patent No. 548,623. As a result of his examination of the two Tainter patents, and of the five Edison patents, first above referred to, he reached the following conclusion:

> "I find therefore, from this review of the art that the materials heretofore employed, for making sound records, whether duplicates or originals, are materials of a wax or wax-like character, and that in the art the equivalency of metallic soap and fatty acids with waxes, such as bees' wax, carnauba wax, ceresin, and mixtures or compositions containing these, is fully recognized. I also find that it is recognized in the art that when a

> material is to be cut by the engraving style of the machine, it is desirable that it should have a certain degree of hardness, but that it should not be so hard as to offer too much resistance to the vibrating action of the style; and it is also recognized that when a material is to be molded to form a duplicate, as by melting it and pouring it into a mold, formed by electrodeposited metal upon an original, the material may be, and preferably should be, harder than that which would be employed when the records is to be cut by a vibratory style under the influence of sound waves."

It seems to me that these conclusions do not recognize the great difference between the art of making original records and the art of making molded duplicate records, nor do they recognize the great difference between a suitable composition for making a blank on which a record can be directly recorded, and a composition which can be successfully used for making duplicates, nor do the conclusions apparently recognize the actual situation as it existed in the early days of the commercial phonographic art. As a matter of fact, only one of these patents (Edison No. 484,582) refers to the duplication of records and all the others relate to the making of original records. I have tried to make it clear that there is little or no connection between the art of making original records on a blank tablet, and the art of molding duplicate records. The fact that a composition might be perfect as a blank material would by no means indicate that it would have any utility at all as a material from which to make molded records. In fact the present blank material has not been improved for many years, and it may be considered perfect for its purpose: but it is not suited for the molded record art, and I firmly believe that if the blank material was all that we had, the molded record art would be materially behind its present state of development. Furthermore, many, if not all of the patents, reviewed by Mr. Cameron, in his answer, describe inventions that are obsolete and have been obsolete far many years—inventions that preceded the development of the present blank composition and were relegated to the background by the blank composition and are now looked upon only as historical curiosities. For instance, the Tainter patent No. 421,450 of February 18th, 1890, (application filed November 14th, 1887) suggests the possibility of employing ozokerite, either alone or mixed with "bees' wax, carnauba wax, and others" as a coating for a paper tube to constitute a recording tablet. Ozorkerite, as I have previously said, is crude ceresin, and is now obsolete, although ceresin is used as an ingredient of both blank and molded record compositions. But no one would think now of attempting to use ozokerite or ceresin alone, or mixed with bees' wax or carnauba wax, even as recording material, because the blank composition is so infinitely superior for that purpose. Of course, as for attempting to use ozokerite or ceresin alone, or mixed with bees' wax or carnauba wax, as a material from which to make molded records, it would simply be out of the question, since the material would be totally unfitted for molding and even if records could be made, they would be worthless. This Tainter patent was filed about a year previous to the development of the modern soap blank, which immediately displaced all other materials on which to record directly. The second Tainter patent No. 393,190, although earlier in date of issue, *i. e.* November 20, 1888, was filed five days after the other case and refers to the latter in the specification. This Tainter patent describes a composition of bees' wax and carnauba wax, the percentage of carnauba wax being varied according to the seasons, and being higher in summer than winter. Of course a material that had to be changed three or four times and possibly oftener every year, and in connection with which a stock laid in one month might be unfitted for use the following month, would be totally unfit even for the recording art, and certainly for the molded record art. This patent also antedates the invention of the metallic soap composition and with the advent of the latter on the market, it also was displaced, if had ever been used.

Referring now to the several Edison patents, the first patent referred to by Mr. Cameron, No. 400,648, suggests the use of stearic acid, preferably mixed with ceresin, bees' wax or paraffine, or with ceresin and bees' wax, as a material for blanks, but the composition of this patent was not only not used practically, so far as I know, but was also displaced by the modern soap composition. The patents to Tainter and to Edison so far considered are good examples of the early efforts made in the art to produce sound recording materials, and in which all sorts of waxes and gums and fatty acids were mixed together in varying proportions. Personally, I tried thousands of such mixtures and the patents that I review in answer to *Q.* 43 disclose some of the efforts of others in the early days.

The first reference to a metallic soap among the patents mentioned by Mr. Cameron is in patent to Edison, No. 430,274 of June 17th, 1890, the application for which was filed July 30th, 1888, and suggesting preferably a lead soap. This patent was filed at the very commencement of the experimental work that developed the modern soap blank and many things had to be discovered before the bald suggestion of this patent could be turned to any possible value. It had to be discovered that the one effective stearate for use as the base of a recording composition was stearate of soda; it had to be discovered that there must be present a considerable proportion of free stearic acid, means had to be discovered for correcting the crystalline tendency of the stearate of soda, and finally means had to be discovered for overcoming the hygroscopic nature of the material. All of this succeeded the application for Edison patent No. 430,274, and even when all that work had been done, we had in the art only the present blank composition and we did not have in the art a suitable molded record composition.

The next patent in order of date of filing, referred to by Mr. Cameron, is Edison patent No. 488,191, of December 20th, 1892, application filed January 19th, 1889. Although at the date of the application for this patent the modern blank composition was pretty well developed; this patent has no relation whatever to the blank art or to the molded record art, but it relates to a scheme on which Mr. Edison was working in the early days and which never materialized into successful accomplishment. That scheme was to make the recording tablets of flexible material, so that they could be folded and sent through the mails in an envelope. Consequently, the important consideration was to make a material that would be highly flexible, and the patent states that:

> "There are many compounds of wax or wax-like material which may be employed for the purposes of my invention. What I prefer to use is a mixture of asphalt, with Japan wax, or pitches made from the distillation of fatty oils, or combinations of fatty acids, any of which materials are equivalents of wax for the purposes of this invention. The proportion of the different substances will vary as the conditions differ and as sheets of *different degrees of flexibility are required.*"

The last Edison patent referred to by Mr. Cameron in his answer—that is to say, last in order of filing—is No. 484,583 of October 18th, 1892, filed May 27th, 1890. This patent relates specifically to a jewel recording tool and states that:

> "The *recording surface of the phonogram blank* is ordinarily of wax or a stearate or hard metallic soap, or other wax-like material or composition" (p. 1, lines 22-26).

Having reviewed the same patents that Mr. Cameron considers (except Edison patent 484,582, which I will soon refer to) it is not a fact that "in the art equivalency of metallic soap and fatty acids with waxes, such as bees' wax, carnauba wax, ceresin and mixtures or compositions containing these, is fully recognized." That is, in the art of duplicating sound records as claimed by Mr. Cameron. It is, of course, true that there were many materials known of a wax-like nature that could be used for recording purposes—in other words, they had the necessary wax-like properties that enabled an original record to be cut into the surface by the action of the recording stylus. Of the several materials mentioned by Mr. Cameron, *i. e.,* metallic soap, fatty acids, bees' wax, carnauba wax, and ceresin, it is evident that they are all of themselves fitted more or less perfectly for receiving original records, and in this sense I suppose there is a certain degree of equivalency between them, although in a practical sense there is very little in common, for example, between an effective metallic soap composition and compositions of ozokerite and carnauba wax, or carnauba wax and bees' wax, as suggested by Tainter, or stearic acid and ceresin as suggested in the earlier Edison patent. But, because these ingredients may be all wax-like and in that sense possible equivalents in the art of making original records, it by no means follows that they are equivalents in the art of making molded records. If these ingredients were all equivalents, then apparently one could be as readily used as the other, and the fact that such is not the case would indicate to my mind that they are not equivalents.

In order to show that the equivalency of these different materials extends to the molded record art, Mr. Cameron refers to Edison patent No. 484,582 of October 18th, 1892, application filed January 5th, 1888, but this patent was applied for long before metallic soap compositions were known, and when as a matter of fact, the Edison Company was using a mixture of ceresin and carnauba, which has none of the attributes of a successful molded record composition, either in molding properties or in the results to be obtained from it. At the date of the application for this Edison patent, the only known material, so far as the literature of the art is concerned, that had been suggested for recording purposes, were compositions employing such waxes as bees' wax, carnauba wax, and myrtle wax, and such wax-like materials as ceresin and paraffin. The use of stearic acid or metallic stearates, or stearates of soda, and the other materials entering into the modern blank composition, was quite unknown, when this Edison application was filed. The application refers broadly to "resins" but does not attempt to specify any particular resin that might be used; and it finally refers to "Plaster-of-Paris," which could have no utility in the modern art because a record made of plaster-of-Paris, could not be shrunk out of a continuous mold. For this reason, apparently, Mr. Edison in his patent shows the mold divided into three parts, so that after the record is made the mold can be opened to permit the record to be taken out. While the patent states that the material used is "preferably too hard to be satisfactorily indented with the phonograph," it does not except possibly in the case of plaster-of-Paris mention any material of that character.

Making a direct answer, therefore, to your question I would agree with Mr. Cameron, if his conclusion was modified to the extent that while the prior art might have recognized the equivalency of many materials as suitable for use in the make-up of compositions on which original records may be made, it is quite silent as to the equivalency of these or any materials in connection with the molding of phonograph records. And, I also agree with Mr. Cameron that Mr. Edison recognized the importance of using a hard material from which to make records, although he does not suggest any such hard material. And, I will further say in answer to the question that if it be admitted that in a general way many materials were wax-like in character, so far as their capacity to be cut by a recording stylus is concerned, that fact would have absolutely no bearing upon, or relation to, the possibility of their use in compositions for making molded records. The two arts are quite dissimilar in many respects. They are practiced in different ways, they result in different products, and they make use necessarily of different compositions. With the recording art, the essential feature of the composition next to its smoothness, is its capacity to be cleanly and readily cut by the microscopic recording stylus. With the molded record art, it is absolutely immaterial whether the composition can be cut by a recording stylus, and as a matter of fact, it can only very imperfectly be cut by a recorder. In the recording art, warping and shrinking in manufacture are absolutely immaterial, because the blanks are trued up after they are seasoned, but with the molded record art, warping and shrinking are factors which must be carefully avoided.

*Q.* 246. In answer to *Q.* 4 of his deposition, Mr. Cameron states that the Edison patent No. 406,576, recognizes the fact concerning carnauba wax, that advantage may be taken of its shrinking properties in passing from a molten to a hard or set condition. What bearing, if any, has this fact on the molded record art?

*A.* The Edison patent describes a composite recording blank, having an outer surface of a metallic soap, such as stearate of soda, and a body of asphalt. It is pointed out that in molding asphalt "it does not contract in hardening, and it is therefore, difficult to get it out of the mold again. By mixing from five to seven per cent. of carnauba wax with the asphalt, a compound is formed which shrinks slightly in hardening, and can therefore be readily removed from the mold" (p. 1, l. 72-79). With Edison, dealing with a non-contracting material, the sole purpose of adding carnauba was to produce shrinkage. It did not contribute to the hardness, in fact, the *recording* surface is the usual material, and there was manifestly no problem of warping or uneven shrinkage to be overcome, or in fact, any of the factors to be reckoned with in the molded record art. With the composition of the patent in suit, there is no need to take "advantage" of the excessive shrinkage of carnauba; in fact, the blank composition possesses sufficient shrinkage. I have pointed out that apparently the effect of adding carnauba to any composition would be to impart to the same excessive shrinkage and great warping, but I found that, contrary to my expectations, by adding carnauba (which warps and shrinks excessively) to a metallic soap composition (which also warps and shrinks excessively) I obtained a composition in which warping and shrinking were greatly reduced and made very much more uniform.

*Q.* 247. I call your attention to Mr. Cameron's answer to *Q.* 10 of his deposition, and ask if you agree with the conclusion reached by him therein?

*A.* I understand that Mr. Cameron is not a practical man and that he has had no practical experience with the development or manipulation of sound record composition. If Mr. Cameron had been a practical man, I think he would have reached another conclusion. His position is based entirely on the theory that the ordinary blank composition (such as is described in Macdonald patent No. 606,725) possesses every single characteristic that a successful molded record composition should have, except the one characteristic of hardness, and that the addition of carnauba wax supplies this one and only this one characteristic; and his further theory is that since carnauba wax had previously been used in connection with ozokerite and bees' wax it could obviously be employed in connection with and as an addition to the blank composition. Now, as a matter of fact, as I have previously testified, the blank composition is not suitable in the molded record art, and would not be suitable for that art, if sufficiently hard. Mr. Cameron, for instance, states that "experience has taught that it does not stick or adhere to the mold," when as a matter of fact, the experience of the art is just to the contrary, and the blank composition does stick to the mold, and if used would make the surface rough and foggy. He also says that "experience has taught that records molded from this material shrink away from the mold without warping, so as to render it incapable of use on standard talking machines;" experience has taught just the contrary, and we know that the blank composition is fatally defective in this respect. Mr. Cameron states that if carnauba wax were added to the blank composition it "would not interfere with, but would possibly slightly increase the shrinking properties of the composition." He reaches this conclusion from the Edison patent No. 406,576, which states that the addition of carnauba wax to asphalt will increase the shrinking properties of the latter. This shows how utterly impossible it is to assume that because a certain result takes place with one composition the same result is going to take place in another composition, because, as a matter of fact, the carnauba wax *decreases* the shrinking of the blank composition. He says that if a person added carnauba wax to the blank composition "he would know from the same patent that it would not interfere with the limpidity imparted to the composition by the ceresin wax." As a matter of fact, as I have previously testified, the presence of the carnauba actually increases the limpidity. Furthermore, he says that such a person "would have been taught by the Tainter patent No. 393,190, that it would not interfere with the fine texture, which would enable the material to be cut smoothly." The fineness of texture has nothing whatever to do with the capacity of the material to be cut smoothly while hot (which I presume is what Mr. Cameron is referring to, because that is the characteristic set forth in the patent in suit) but is dependent on the molecular conditions. Some compositions are of very fine texture, and cannot be cut smoothly while hot; for example, this Tainter patent on which Mr. Cameron relies, describing the composition of carnauba and bees' wax, is a very good illustration of just such a composition. If such a composition could be molded as a record, it could not be cut smoothly while hot, but the material would follow the cutting knife, so as to drag the record out of the mold. Another illustration of such a composition is found in my patent, No. 676,111, referred to in answer to *Q.* 48. That was a composition with a very fine texture, but I was unable to effectively ream it while hot.

In view of these facts, I believe that Mr. Cameron has reached the conclusion that he has, without really understanding the situation. The addition of carnauba does more than to increase the hardness of the composition, since it also results in the composition having properties that are not found in the blank composition, or in carnauba when considered individually. And the addition of carnauba results in properties which no one could possibly foretell without experiment. Furthermore, even if the only function of the carnauba was to increase the hardness of the blank composition, I do not see how any one could tell without experiment that the carnauba would be miscible with the blank composition. Although I had been familiar with carnauba for many years, as well as with the blank composition, I did not know that they were miscible, and in view of the complex nature of the materials entering into these compositions, I would not undertake to say myself, until I had found out by experiment, that carnauba wax would be miscible with the blank composition. Mr. Cameron seems to suppose that it follows as a mathematical certainty that since carnauba wax is miscible with bees' wax or paraffin, it is also miscible with the blank composition, but that of course does not follow because there are other materials with which carnauba wax is miscible and which are not miscible with the blank composition. For example, carnauba wax is miscible with asphalt as stated in Edison patent No. 406,576, but asphalt is not miscible with the blank composition. And, there are other materials with which the same uncertainty arises. Considering the enormously complex character of the blank composition I do not believe that any chemist, however skillful he might be, could unerringly predict that a certain material or class of materials would be miscible with the blank composition, or that another material or class of materials would not be.

*Q.* 248. Have you read the deposition of Professor Holton, one of the defendant's chemical experts, who testified herein?

*A.* I have

*Q.* 249. Before taking up Professor Holton's deposition, please refer to the records mentioned in your answer to *R-dQ.* 227, and state of what composition and by what process the three million records therein mentioned were made?

*A.* Those records were made of the exact composition and by the exact process described in the patent in suit between lines 24 and 101 inclusive of page 2, thereof.

*Q.* 250. Kindly take up Professor Holton's deposition and refer to his answer to *Q.* 3, in which he states that

> "Carnauba wax itself is chiefly composed of a hard wax-like compound ether (myricyl ceretate) and a minute quantity of free alcohol (myricyl alcohol)."

Does this statement of Professor Holton agree with the literature on the subject of carnauba wax?

*A.* It does not. The literature on the constitution of carnauba wax varies as to the constitution of the same, but the general opinion of the writers on the subject favors the conclusion that the percentage of free myrical alcohol in carnauba is very considerable. I have already referred to the fact (in my answer to *xQ.* 223) that the proportion of free myrical alcohol as determined by Story-Maskylene was 30%. This was confirmed by Sturcke, who is the one authority from whom all the modern books has derived their information on this subject. In Watt's Dictionary of Chemistry, (Revised Edition 1888,) the authority on chemical matters in general, it is stated that:

> "The greater part of the wax is myricyl ceretate and myricyl alcohol."

It is true that in the book by Lewkowitsch (referred to by Professor Holton in answer to *xQ.* 69 of his deposition), that writer states that the wax contains "small quantities of free cerotic acid and myricyl alcohol." In a work such as that of Lewkowitsch, dealing with many thousand substances, the information is necessarily based on the investigation of others, and Lewkowitsch derives his information concerning carnauba from the work of Sturcke, which is directly referred to. Undoubtedly Lewkowitsch incorrectly abstracted the work of Sturcke in this particular, because the conclusion stated by Lewkowitsch does not correspond with Sturcke investigations. I have carefully read a full translation of Sturcke's work on carnauba wax, which I understand is to be introduced in connection with the deposition of Professor Stillman.

Furthermore, in Wright's well known standard work on "The Analysis of Oils and Allied Substances" (London, 1903) he criticises this very statement of Lewkowitsch and says (page 229):

> "Carnauba wax is chiefly composed of myricyl ceretate; it also contains free ceryl and myricyl alcohols, which must be present in considerable quantity judging

by the large acetyl value (page 144) found by Lewkowitsch."

The interpretation of Sutrcke's works by other authorities such as Watt's Dictionary of Chemistry, above referred to, and "Allen's Commercial Organic Analysis, Volume 2, Part 1 (Phila. 1899)," are contrary to the interpretation of the same as given by Lewkowitsch. I might also say that from my own reading of Professor Sturcke's work, it is perfectly clear that the percentage of free myricyl alcohol determined by him is very considerable.

*Q.* 251. Have you ever had occasion yourself to determine the fact whether carnauba wax does contain free myricyl or other alcohol, and if so, when did you make that determination and with what result?

*A.* Up to the time of filing the application for my patent I had made no investigation into the chemistry of carnauba wax. I observed, however, that in the manufacture of the composition a chemical reaction took place, and knowing from my experience with the blank composition that it contained free stearic acid, and being informed by the literature that carnauba wax contained free alcohols, I felt reasonably certain that an ester or compound ether was formed, due to the reaction between the free stearic acid and the free alcohol or alcohols, as such reaction would, in addition to the product of a compound ester, form water which would cause the foaming noticed. Also, when I examined the six Columbia records referred to in my first deposition, and the analysis of which appears in my answer to *Q.* 8 thereof, I then determined that there were present in defendant's composition compound ethers different from any which exist in carnauba wax, and which could be caused by nothing else than the reaction between the free stearic acid and the free alcohol or alcohols, or possibly an interchange of acids between the stearate of soda and the cerotate of myricyl (the ester which is present in carnauba wax) which latter interchange may take place in addition to the formation of the compound ether referred to. This determination of the presence of new compound ethers in defendant's composition was made by separating the whole amount of the compound ethers present in the composition, saponifying the same with caustic potash in alcoholic solution, and separating the alcohols and hydro-carbons from the potash soap of the ester and then decomposing the soap by acid treatment in the regular methods of soap analysis to separate the fatty acids. These fatty acids after washing and drying had a melting point much lower than the fatty acids which are contained in carnauba wax. After

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noting this a further separation of these fatty acids was effected, resulting in a mixture of fatty acids having a melting point of 59 degrees centigrade, and a crude cerotic acid having a melting point of 79 degrees centigrade; over ⅔ of the total fatty acids thus separated were of a much lower melting point. Now since carnauba wax does not contain fatty acids of this melting point, therefore the esters from which these acids were obtained are entirely different from any which were introduced by the addition of the carnauba, and hence it would follow that the carnauba wax must have contained free alcohol.

During the past ten days I have in collaboration with Professor Stillman of Stevens Institute, made very elaborate experiments in connection with these matters, including the determination of the substantial percentage of free alcohol in carnauba wax. The experiments were conducted principally on two separate lines of investigation: First, the reaction which causes foaming was investigated in the following manner: The soap composition of the patent, without the addition of carnauba or ceresin or lamp black, was prepared. The carnauba wax was purchased in the open market by Dr. Stillman. This material was the substance which is used in the talking machine industry and is imported from Brazil by Smith & Nichols, a firm doing business in New York, and from whom I observe defendant also buys its carnauba wax. This carnauba wax was washed in the manner described in the patent, and after separating from the water and then remelting to drive off any remaining water, was carefully filtered through the cloth used in filter presses, and after filtering was heated up to 450° F., to make sure that all water was removed. At this temperature the wax was perfectly tranquil and free from bubbles or any indication of decomposition. It was then cooled down and marked and was ready for use in succeeding tests and experiments. The stearic acid was obtained in the open market and is the very best grade obtainable, known as the "Century" brand. The soap composition of the patent was also heated up to a temperature of 450° for about two hours and was free from any signs of decomposition products as evidenced by absence from foaming or bubbling. This soap composition of the patent and the purified carnauba wax, and the mixture of the soap composition and the carnauba wax placed in separate flasks having an inlet and outlet for the purpose of displacing the air by nitrogen, were heated in a wax bath to a temperature of about 450°, and provision was made to connect the flask with apparatus which would catch all fatty vapors, such as stearic acid, which might be evolved, and also provision to catch and determine the weight of water which might be evolved in each case. The substances were heated in a slow current of perfectly dry nitrogen, until no further ebullition of water occurred. Only an extremely small amount of water was collected from the soap composition and the carnauba wax separately heated, but from the mixture of the soap composition and the carnauba wax there was evolved sufficient water to account for about 30% of free myricyl alcohol in the carnauba wax used. Now, since the substances separately heated did not evolve the water, which was evolved only in the case of the mixture, and knowing the composition of the soap material to contain free acid, this forms very strong proof that there is reaction between the free acid and free alcohol to form an ester.

Second, the soap composition of the patent the same as used in the preceding demonstration in accurately weighed amount, and carnauba wax in accurately weighed amount, and the mixture of the two in the proportions of the patent, accurately weighed, were each heated to 450° in vessels wherein provision was made that nothing whatever could escape as vapor. The three separate vessels were heated in the same wax bath to insure absolutely uniform condition, the heat being maintained for three hours. The object of this experiment was to note how much, if any, of the free stearic acid of the patented composition (*i. e.,* the soap mixture and the carnauba) disappears to form esters or compound ethers by the combination of the free stearic acid with the free alcohol of the carnauba wax. To this end, after the completion of the heating at 450° under identically uniform conditions, the free acids contained in and evolved from the soap mixture separately heated were accurately determined, the free acids contained in or evolved from the carnauba wax were accurately determined, and the free acids contained in and evolved from the mixture of the metallic soap and carnauba wax were also accurately determined. Obviously, if there was no combination between the free stearic acid and the alcohol of the carnauba wax in the case of the mixture of the soap composition and the carnauba wax, then the free acids contained in and evolved from the soap composition as separately heated and the carnauba wax as separately heated—that is to say, the combined acids from both of these sources—should correspond identically with the free acids contained in and evolved from the mixture of the soap composition and carnauba when heated together, because the total weight of the soap composition was the same in each case as also the weight of the carnauba. Now, if after such a demonstration it were found that the free acids contained in and evolved from the mixture of the metallic soap and carnauba were less than the combined amounts of free acids contained in and evolved from the separately heated metallic soap and the separately heated carnauba, the difference would indicate the amount of free acids that had entered into combination with the free alcohol or alcohols of the carnauba wax. The result of this test showed the disappearance of a sufficient amount of free stearic acid in the case of the mixture of metallic soap and carnauba wax to account for the presence of a very considerable proportion of free myricyl alcohol in the carnauba wax. I might mention as a confirmatory fact that in the titration of the free acids, I observed that in the case of the mixture of the soap composition and carnauba wax, there was a very much larger proportion of insoluble ethers present in the solution than was present in the combined solutions of the carnauba wax and the metallic soap composition as heated separately. This was an ocular confirmation of the results obtained by the chemical experiments referred to. In fact, as a result of these experiments I am almost inclined to believe from large percentage of myricyl alcohol necessary to combine with the free stearic acid found to have disappeared, that a part of the free stearic acid may have displaced a part or all of the combined cerotic acid, so that instead of having myricyl ceretate (the natural compound ether of the wax) we would have only myricyl stearate, the new wax-like compound ether. But that there is free myricyl alcohol in the carnauba wax and that a reaction between the same and the free stearic acid occurs to form myricyl stearate, the experiments made by Professor Stillman and myself satisfy my mind beyond the possibility of a doubt.

*Q.* 252. From what you have just said, I take it that you do not agree with the statement of Professor Holton contained in answer to *Q.* 3, and elsewhere expressed in his deposition that:

> "It is barely within the range of possibility that the minute quantity of free alcohol contained in carnauba wax might react under the temperatures mentioned upon some of the free stearic acid, so as to produce a very small additional quantity of wax-like compound ether, but if this reaction does occur (and as to whether it does or not, no scientific chemist is yet able to state authoritively) the quantity of wax-like ethers thus produced in so minute as to be entirely negligible."

*A.* No, I do not agree with Professor Holton, who cites no proof whatever in support of his statement. I have found, as a matter of demonstration, first, that there is a large quantity of free alcohol in carnauba wax, second, that beyond any question whatever, there is a reaction between the free alcohol and the free stearic acid, third, that a very large amount of wax-like ethers result from this reaction, and fourth that, regardless of the amount of compound ethers formed, the result is not negligible, but is commercially of the highest importance.

*Q.* 253. In answer to *Q.* 11 Professor Holton states that certain figures given by you in answer to *xQ.* 75 of your former deposition are incorrect. Do you agree with Professor Holton in this respect?

*A.* Yes, the figures as given by me on cross-examination are wrong. These calculations were hurriedly made in response to the question by Mr. Massie, and there was a mistake in arithmetic. Of course, if I had gone over the figures carefully I would have detected the error.

*Q.* 254. Professor Holton in answer to *Q.* 14, referring to Edison patent No. 400,648, describing a composition in which stearic acid and bees' wax are used, states that the combination of the free alcohol of the bee's wax and the stearic acid "would make a wax-like compound ether" if the two were simply melted together. Is this correct?

*A.* This is not correct. There could be no combination of stearic acid and free alcohol by simply mixing the melted substances together. Combination would only take place by the aid of a very much higher temperature than that necessary to melt the two substances, or by the introduction of a dehydrating substance, such as hydrochloric acid gas, or strong sulphuric acid.

*Q.* 255. Professor Holton in answer to *Q.* 17, seems to think that the frothing which takes place when the carnauba wax is added, as described in the patent in suit "is by no means a conclusive proof that a chemical action is taking place," and he suggests that when carnauba wax alone is subjected to a high temperature a violent foaming and frothing takes place, due to the elimination of contained moisture and air therein. He also points out that in heating a composition to a high temperature suggested in the patent, the parts of the mass closest to the heat are likely to be volatilized or dis-associated to cause frothing or foaming. Do you regard Professor Holton's criticisms of the frothing or foaming test as being valid?

*A.* I do not; Professor Holton's statement is misleading, and shows a very imperfect observation of what takes place when carnauba wax is melted. The fact is that carnauba wax in its crude form as purchased in the market usually does contain mechanically mixed water and air, but the mere act of melting at a temperature of boiling water or slightly higher, eliminates this water and air and the wax then becomes perfectly tranquil and free from froth or foam. In the course of the manufacture of the patented composition all these causes of froth and foam were eliminated from the carnauba wax before it was added to the soap mixture, so that any frothing which takes place afterward is not due to the water contained in the carnauba wax as stated by Professor Holton. As to the decomposition at the points of contact with the vessel in which the compositions are heated, in the ordinary practice in making these compositions the vessel is so arranged that it becomes uniformly heated, so as to avoid any such decomposition, and this eliminates the possibility of decomposition as stated by Professor Holton taking place and accounting for the foaming noticed in making the composition. Furthermore, if such decomposition due to overheating caused the excessive foaming noted, the same would take place with the blank composition which is heated in the same manner and with which no foaming does take place, excepting that due to the reaction in making the soap composition, which is characteristically different from that due to the reactions of carnauba and is finished in a much less time.

*Q.* 256. From your extensive experience as a commercial chemist, particularly versed in this art, and observing the precautions which you do observe in the manufacture of the composition, would you regard the prolonged and characteristic frothing and foaming as being a substantially conclusive indication that a chemical reaction was taking place?

*A.* Yes, even if I had never made any other tests in the matter, and the precautions as to heating both substances up previous to their mixture had been carefully carried out, I should consider the evidence of frothing and foaming noted on their mixture at the high heat to be a very conclusive indication that a chemical reaction was taking place, and knowing the nature of the material, the only logical conclusion that could be arrived at under those circumstances would be that water was being given off by the reaction and that an ester reaction was taking place.

*Q.* 257. In answer to *Q.* 18 Professor Holton questions the conclusive nature of your statement that another indication of the formation of the compound ether is the different nature of the two compositions made at a high temperature and at a low temperature. He states that the mere heating of such a mixture for an extended time "contributes materially to emphasize this change in the physical characteristics of the material wholly independent of any chemical reaction" and that this physical change "alone would cause the molded composition to offer greater resistance to the wearing action of the stylus," and in this connection he refers to Tainter patent No. 421450, as an example of the concentration or toughening of a material by prolonged boiling. In your opinion, has Professor Holton adequately disposed of this evidence of the formation of a compound ether as testified to by you?

*A.* No, I do not think so. If Professor Holton had proved or cited any experiments to prove that there was no chemical reaction, and that we still had the physical differences noted, then there would be some grounds for his statement. His reference to the Tainter patent No. 421,450 does not seem to me to be pertinent, because that patent relates only to the idea of boiling ozokerite, so as to drive off the volatile impurities, and consequently make it tougher; but in this art the high heating does not drive off any volatile impurities, although a certain amount of stearic acid is volatilized, but this we replace at the end of the operation. This particular observation I made not for the purpose of having it stand alone as an indication of the formation of a compound ether, or of some other chemical change, but as confirming the other reasons. In most chemical work the manifestation of a single phenomenon while it may be indicative of a certain chemical effect, would not be accepted as necessarily conclusive; but if we encounter several phenomena, all indicating the same effect, we can safely assume the effect to be conclusively demonstrated.

*Q.* 258. In answer to *Q.* 17, *xQ.* 81, and *xQ.* 123, Professor Holton expresses the opinion from the analysis made by you of defendant's records, and from the analysis made by him of certain experimental records introduced by Mr. Thornberry, that all the free stearic acid is accounted for, so that none could exist in combination with the free alcohols of the carnauba wax. Do you regard Professor Holton's views in this respect as sound?

*A.* No, I regard Professor Holton's deductions and calculations as contained in the answers to the questions referred to as most unscientific and unreliable. He attempts to compare the analysis of a composition made previous to March 20th, 1905 (the date when I received defendant's records for analysis), with

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the calculated percentage of a composition known to contain a different precentage of carnauba, and in which he assumes the commercial materials used in the one case to have the same definite composition as they do in the other case. The Thornberry composition was made in December, 1906, nearly two years after the records which I analyzed were made. The free stearic acid contents of these compositions will vary as much as 10% in two different lots, due to acid vaporization, and the variation of the $Na_2O$ contents of the caustic soda and sal-soda ingredients. He assumes, I observe in answer to *Q.* 11, that the free acid is pure stearic acid, and calculates 25.4%, and in *xQ.* 81, he assumes that the free acid is the commercial article, and calculates 27.6% of free acid. In his determination, by experiment of the free acid in the Thornberry record, he does not state whether he determined it as pure stearic acid or as the commercial article, but he adopts the calculated amount—27.6—in making his comparison. It is impossible to calculate with exactness the true percentage composition of a compound made from a formula in which commercial chemicals known to vary are used, and in which some of the ingredients are volatilized during the manufacture of the compound and during the manufacture of the product from the compound. Variations could easily occur amounting to several per cent. between calculations thus made and the exact composition as determined by analysis. It only requires a very small percentage of free stearic acid to disappear in combination with the amount of myricyl alcohol contained in carnauba wax in the proportion as shown by the analysis, namely about 8%, even assuming that 30% of this 8% is free myricyl alcohol. The calculated amount of palmitic acid required to combine with the free myricyl alcohol contained in the amount of carnauba contained in defendant's record, as shown by analysis, would be 1.4%) assuming that the carnauba contained 30% of free myricyl alcohol). Now, since the Thornberry record referred to stated to contain 6% of carnauba, the amount of free palmitic acid required in this case would be still smaller. Calculating the amount of pure stearic acid required for the Columbia record would be 1.56%, and for the Thornberry record somewhat less than this. Then, if we assume the free acid to be composed of half stearic and half palmitic, the Columbia record analyzed would require 1.48% of free stearic acid, and the Thornberry record somewhat less than this amount to combine with the free myricyl alcohol even assuming that the carnauba wax used contained as much as 30% of free myricyl alcohol. If Professor

Holton had made up two compositions with exactness of the same ingredients, and taken care that no acid vapor escaped, in one of which he added carnauba wax in the proportion indicated in my analysis, and in the other no carnauba wax, and had then determined after heating both compositions for the same length of time, and at the temperature mentioned in the patent and had then determined by analysis the percentage of free stearic acid in each, and if he found that the amount of free stearic was the same in both, then his deductions would be correct. In the manner he has arrived at his conclusions, they are of no value whatever as proof for or against the formation of an ester in the composition. In addition to the chances of error in Professor Holton's deductions as above pointed out, the analysis which I have made could easily have an error which might affect the free stearic acid calculations of Professor Holton from one to two per cent. I observe further that Professor Holton compares Thornberry record formula B, without carnauba, and Thornberry record, formula B with carnauba, as regards the amount of free stearic acid contained in each, and he states that the quantity found was "practically identical." He gives no figures in his statement as to the amounts found. The same criticism regarding this comparison of formula B with and without carnauba is applicable to this point, as that which I have previously made regarding his comparison of the analysis of defendant's record and the Thornberry record, formula B with carnauba. Since the percentage of free stearic acid necessary to combine with 30% of myricyl alcohol contained in the amount of carnauba wax added to the Thornberry composition would be less than 1½%, this relatively small amount may have been regarded by Professor Holton as immaterial; at least he gives no figures to determine what the variation was between the two compositions, and the fact that Professor Holton did not find them to be absolutely identical means, of course that there was some difference. Furthermore, it is to be observed that Professor Holton found the amount of free stearic acid in the Thornberry composition with carnauba to be "practically identical with the free stearic acid in the Thornberry record without carnauba." Now in the former case, we have 6% of carnauba wax which must be taken into account, so that leaving out of consideration all reactions and regarding the two compositions as absolutely alike in every other respect, the quantity of free stearic acid should not be identical in the two cases, but there will be a variation of at least 1%. Apparently, therefore, Professor Holton regards a small variation of this amount as immaterial, when, as a matter of fact, it is enough to take care of 30% of free myricyl alcohol.

*Q*. 259. In answer to *xQ*. 66, Professor Holton considers the several hardening materials known in the prior art, but he does not seem to be able to say with any degree of positiveness that any of these materials, except carnauba wax, could be effectively used, nor is he able to say which materials would be miscible and which would not be. He does, however, refer to the possibility of using sand and other gritty materials, and states that these "would be undesirable ingredients to add for the purpose of hardening the soap composition of the patent in suit." Why would the use of sand, or other gritty material, be undesirable?

*A*. Looking at the matter superficially, it would appear that if you add a gritty material to the composition it would naturally make a rough surface, and this I have no doubt was the way in which the question was regarded by Professor Holton, as well as Mr. Cameron, who testified to the same effect. A man, however, like Mr. Edison, giving intelligent and careful thought to the matter would conclude that since the gritty particles were admixed with an extremely limpid composition, the composition would flow completely around and cover the gritty particles, so that the surface would be perfectly smooth, and when Mr. Edison suggested in his patent No. 713,209, that the metallic soap composition might be admixed with gritty materials, he no doubt argued in this way. And, in this respect, Mr. Edison was very largely right, because we find in the molded record art that careful filtering to remove foreign particles, such as dust and dirt which get into the scrap composition, is not necessary as in the manufacture of the blank composition, where a surface has to be produced on which a record can be cut. And, in the manufacture of a molded record composition, even when quite large percentages of gritty substances are added, the surface looks to the eye to be perfect, but to the ear the reproduction is rough, although not so rough as one might think. The reason for this roughness is that the shrinkage of the composition is greater than that of the gritty particles, which from this cause produce microscopic irregularities in the surface, but this fact could only be determined by experiment.

*Q*. 260. In *R-dQ*. 148 and *R-dQ*. 150, Professor Holton states that with the composition of formula B of Macdonald patent No. 606,725, the amount of free stearic acid would be 122.4 pounds. Would it, in your opinion, be possible to accurately calculate the amount of free stearic acid obtainable under the conditions assumed by Professor Holton?

*A.* Macdonald formula B, as given by Mr. Thornberry in his answer to *Q.* 59, gives the following:

| | | |
|---|---|---|
| "Stearic acid | 300 | lbs. |
| Aluminum powder | 1.5 | " |
| Caustic soda lye | 9 | " |
| Sal-soda | 60 | " |
| Ceresin | 60 | " |
| Water | 12 | gals. |

It would be absolutely impossible to calculate with exactness the amount of free stearic acid that would be in the composition when finished made from this formula, even if there were no less of stearic acid from vaporization which inevitably does take place to quite a large extent, depending on the time the material is heated at the high temperature and upon the temperature of the stearic acid during the adding of the ingredients. But, leaving this vaporization out of consideration, we have first, aluminum powder 1.5 lbs. Now, this aluminum powder has an impurity of about 2%, which is variable, and which would largely alter the calculations of free stearic acid; second, the caustic soda lye varies within large limits. This would also greatly affect the percentage of free stearic acid. Third, the sal-soda is a crystalline substance containing 10 molecules of water, which on exposure to the air loses a large quantity of water, and changes in its percentage of $Na_2O$ to quite a large extent. This also would have a very large influence on the amount of free stearic acid. The ceresin vaporizes during the heating and could not be figured as the full amount given in the formula. Now, in making a calculation like that of Professor Holton, and leaving out entirely the important factor of loss by vaporization of stearic acid, it would be possible to take as examples of these variable factors figures which would give results at least 10 pounds on either side of the amount calculated by Professor Holton, or, in other words, within those limits, it would be possible to get any result we wanted to get. On the subject of vaporization of the stearic acid, I know from experience that its loss is in the neighborhood of 10% of the free stearic acid, or about 2% of the whole composition. These calculations of Professor Holton are to my mind as unscientific and unfair as if a person having a problem in algebra to solve, and knowing the answer, were allowed to give any values he saw fit to the symbols.

*Q.* 261. In answer to *R-dQ.* 152 Professor Holton states that the amount of free stearic acid determined by him from analysis of "Thornberry record formula B with carnauba" assuming the amounts of the composition to be those given in Macdonald patent No. 606,725, to be 122.5 pounds as against 122.4 pounds, found by his calculation of the formula of that patent, and he concludes (*R-dQ.* 153) that this coincidence in figures " is a practical demonstration that there has been no such reaction" between any free stearic acid and free alcohols in carnauba wax. Do you agree with Professor Holton in this respect?

*A.* I do not consider that this coincidence in figures proves anything regarding the reaction of free myricyl alcohol in carnauba wax and the stearic acid, because as I have stated before, even assuming that there would be no loss of stearic acid, due to vaporization, the value given in the calculated result might be varied within wide limits by assuming various degrees of purity of the ingredients. Then aside from this, it was stated by Mr. Thornberry that the composition in question was cooked for 13½ hours. This long cooking at a high temperature would cause a variation in the amount of free stearic acid of at least 5% of the whole composition, or about 20% of the free stearic acid. Then, if stearic acid were added to make up for this vaporization, the amount added would have to be considered, and furthermore, during the molding operations, there are slight losses of stearic acid. Even assuming that there was no reaction, which is the basis of Professor Holton's assumption, we would expect a considerable variation in the amount of free stearic acid, where, on the contrary, in his statement he has identical or practically identical figures with the two compositions. This coincidence means nothing, and in fact the entire calculation of Professor Holton means nothing. There might be considerable reaction in one case and no reaction in the other case, and it would be readily possible to obtain the same figures in the two cases by simply giving different values to the ingredients used as to their purity. It would be just as impossible to make a fair and accurate comparison between a paper formula, such as that of the Macdonald patent, and a formula derived from actual analysis, as to make a comparison between either formula and the multiplication table.

*Q.* 262. Kindly consider patent to Miller, referred to by Mr. Cameron in *R-dQ.* 76, and state whether this patent describes a composition which would have any utility whatever in the molded record art?

*A.* In the answer referred to Mr. Cameron states only a few of the ingredients referred to in this patent and he does not explain what the patent relates to. The Miller patent is a composition for polishing shoes and not for making molded phonograph records. Mr. Cameron also in describing this composition. mentions as the first ingredient—bar soap, when as a matter of fact, only 3 ounces of soap are used as against 10 pounds of paraffin, 6 pounds of stearic acid, four pounds of bees' wax, two pounds of ivory black, 1½ pounds of lamp black, three ounces of gum-dammar, ten ounces of sugar, one-half gill of alcohol, and one-half gill of turpentine. In other words, the amount of soap used is about 1% of the entire composition, whereas, with a composition suitable for the molded record art, the proportion of soap is about 76%. Bar soap is of no utility in this art, being in the first place a hydrated soap, and in the second place, an oleate, which is very largely hygroscopic. One of the things we have to avoid is the presence of any considerable percentages of any oleate. The composition disclosed in this patent is comparatively soft, much softer than the blank composition, and could not be used successfully for making molded records. Mr. Cameron seems to have some doubt whether the composition of the Miller patent may not have a boiling point as high as 450 to 475° F. As a matter of fact, the boiling point would be that of the most volatile ingredient, which is the alcohol, and this boiling point would be less than 200° F.

*Q.* 263. Have you read the deposition of Professor Charles E. Munroe herein? *A.* I have.

*Q.* 264. Kindly consider the patent to Hart, No. 418,947, referred to by Professor Munroe in answer to *Q.* 8, and state whether this patent describes a composition suitable for use in the molded record art.

*A.* It does not. It describes a composition for crayons, consisting of carnauba wax, stearic acid, and paraffin, in substantially equal proportions, and a suitable coloring pigment, the ingredients being melted and molded into the form of crayons. Such a composition would be much softer than the blank composition and would not be commercially molded. As a composition for the art, it would be far inferior to the *blank* composition.-

*Q.* 265. Having reference to Macdonald reissue patent No. 12,095, and assuming that it were attempted to make molded records from a composition of stearic acid and ceresin, would the effect of suddenly chilling the record cause the harder ingredient to predominate at the surface, as described therein, to form a "casting whose exterior surface is much harder and denser than its mass" (p. 2, lines 15–16).

*A.* No, it would not cause the harder ingredient to segregate and collect on the chilled surface. That is an entirely erroneous idea; on the contrary, suddenly chilling of mixtures of molten substances generally tends to prevent the segregation. What actually does take place is that the sudden chilling renders the surface less crystalline for a short depth only, but this is true of all molded records, no matter what the composition is. It is true of stearic acid alone.

STEVENS INSTITUTE, HOBOKEN, N. J.
Monday, March 18, 1907.

Met pursuant to adjournment.

Counsel present as before.

The witness JONAS W. AYLSWORTH is recalled for the purpose of cross examination in accordance with arrangements previously made between counsel.

CROSS-EXAMINATION by Mr. MASSIE:

*xQ.* 266. I call your attention to your answer to *Q.* 243. In this answer you say the Columbia records copy the phonograph records of complainant in appearance so closely that except for the name on them it is almost impossible to tell them apart. Phonograph records are of a homogeneous composition as distinguishehd from a paper tube having a waxy coating thereon are they not? *A.* They are.

*xQ.* 267. They have an internal taper, instead of a true cylindrical bore and they have internal ribs instead of a smooth surface have they not?

*A.* The phonograph records have an internal taper of bore with concentric parallel ribs.

*xQ.* 268. Do you know whether or not these features are, or at least purport to be, covered by patents owned by the Edison interests; I refer to the fact that the composition is homogeneous instead of being spread on a paper tube, that the cylinders have a tapered bore and have internal ribs.

> Counsel for complainant admits that except for the composition used by defendant, and the process employed by defendant in the manufacture of the records, up to the present time no claim for infringement of any other patent is made.
>
> Defendant's counsel proposes to show that the defendant has the benefit of a license under the patent

referred to, and therefore will object to question 243 and the answer thereto as irrelevant, immaterial and tending to mislead the Court.

Complainant's counsel replies that it is now too late for the defendant to raise any question of license in this case and that no question of license is set up in the answer.

*xQ*. 269. In answer to *Q*. 45 you refer to Edison Patent No. 400,648, and say that the composition of this patent, so far as you know, was not used practically. Do you know whether or not any composition consisting of stearic acid and ceresin was ever used practically for the purpose of phonograph blanks or phonograph cylinders?

*A*. No, I do not know of that particular composition having been used practically for phonograph blanks or for any other form of phonograph cylinders. This answer refers to all the compositions mentioned in this Edison patent.

*xQ*. 270. So far as you know, during the period between the date of the Edison patent just referred to, No. 400,648, and the date of your Aylsworth patent here in suit, was there any soap composition in general use, or in common use for the purpose of phonograph cylinders, consisting of stearic acid and ceresin alone with no other ingredient present?

*A*. The question as you have stated it is not clear. You speak of stearic acid and ceresin alone as being soap composition; this would not be strictly correct; there was, however, between those dates, in general use, a soap composition containing stearic acid, soda, alumina and ceresin. This is a blank composition, practically identical with that which is used today.

Adjourned until Tuesday, March 19, 1907, at 10:30 o'clock A. M. at the office of defendant's counsel, Tribune Building, New York City.

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Office of Philip Mauro, Esq.,
Tribune Bldg., New York City.
Tuesday, March 19, 1907.

Met pursuant to adjournment.

Counsel present as before.

JONAS W. AYLSWORTH.

CROSS-EXAMINATION resumed.

*xQ*. 271. In question 250 after giving Story-Maskylene's figures for the free myricyl alcohol which he thought he found, you say "This was confirmed by Sturcke." What percentage of free myricyl alcohol did Sturcke find?

*A.* Sturcke did not sum up his results and give percentages, but from his figures of the soluble portions of the extracted portion, by hot alcohol, given in his article I calculate that there must be at least 31% of free wax alcohol. Sturcke states

> "Furthermore it is demonstrated by the above determinations that free alcohol even in considerable quantity, is contained therein."

Operating on 1957 gramms of the raw wax by extraction with hot ethyl alcohol, Sturcke obtained 60.04 per cent. of extract; this extract which he obtained, while it does not necessarily represent a completion of the extraction of all matter that might be soluble in hot alcohol, yet would contain the greater portion of all of the free alcohols existing in the wax together with smaller proportions of the esters, which he states, in this same article, are soluble only to a very slight extent in boiling alcohol. By this treatment he gets a residue after extraction, and an extracted portion. The insoluble residue must necessarily contain by far the greater part of the esters which are in carnauba and the extracted matter must contain by far the greater portion of the free alcohol. Then he operates on the residue by saponifying it by prolonged treatment with alcoholic potash, thereby decomposing all of the esters which it contains and setting free the alcohols which existed in it, in combination. Then, after carefully drying this soap formed from the acid that was in the ester, and the alcohols which were combined with cerotic or the other acid to form the ester, he extracts this material; he thereby obtained 51.1 per cent. of extract which represents a fair measure of the alcohols which were in combination in the ester in this particular residue. Then operating in the same manner upon the extract matter obtained from the raw carnauba wax he obtained 78.4% of extract. This figure represents the free alcohol that was contained in the wax together with a smaller amount of alcohol which existed in this original extract in combination with acids in the form of esters, which, as he has stated in this article, were slightly soluble in hot alcohol. While operating on these large amounts by extraction will give a fair indication of the composition yet they are not exactly quantitative and the deductions that can be drawn from them would only indicate the minimum amount of free alcohol. If the extraction were perfect then the result could be accepted as quantitative. Since he obtains an extract amount from the original alcoholic extract after saponification, which he has given as 78.4% of total alcohols from the extracted matter that was soluble in the hot alcohol, therefore that contained practically all of the free alcohol existing in the wax together with a smaller amount of alcohol which existed in the original extract matter as an ester, this ester being slightly soluble in the hot alcohol.

To arrive at an approximation of the amount of the free alcohol that was originally present in the carnauba wax, it will be necessary to know how much of the alcohol compound in this 78.4% was derived from esters. To this end we take the part which did not dissolve in the hot alcohol and which, after saponification to liberate the total alcohols contained in it, gives us 54.1% of extract. This 54.1% of extract can be nothing else but the alcohols and whatever traces of hydrocarbons may have been present in the material.

In this case, as well as in the other cases, where the saponified substances is extracted, the solvent used is petroleum ether, which solvent dissolves the alcohols and hydrocarbons but does not dissolve the potassium or sodium soap combination of the acids. Therefore this residue, of which 54.1% was extract matter, gives a fair estimate of the total alcohols present in the esters contained in carnauba wax. That would leave 45.9% of acid.

Then, by simple proportion, we can figure how much of the 78.4% of extracts, which I have mentioned before as containing the total free alcohols together with the smaller amount of alcohols derived from esters, was ester, in the following manner, the result of which will give us a fair estimate of the minimum quantity of free alcohols in the wax: We take 78.4% from 100; this gives 21.6% of acid occurring in the part soluble in alcohol; then 51.1% were found combined in the residue with 45.9 of acids; therefore, by proportion, there should have been combined with the 21.6 of acids, that were present in the parts soluble in alcohol, 25.4 of combined alcohols; that is to say, alcohols in combination with the 21.6 of acid. Adding these two sums together we get a total of 47% of esters in the extract matter. Then deducting from the 78.4 of alcohols obtainable from the part soluble in hot ethyl alcohol gives 31.4% of alcohols that were in a free state in the original wax.

These figures, of course, are not exactly quantitative, but they indicate that the wax must have contained at least that much free wax alcohol.

Defendant's counsel desires further study of this answer before being able to cross-examine on it, if that can be done at all.

*xQ*. 272. Are we to understand that your conclusion that Sturcke's investigations indicate about 31% of free alcohol in carnauba wax, depends upon the line of reasoning just set forth in your answer?

*A*. As to the figures of the minimum amount, that line of reasoning set forth in my answer would indicate that there is at least 31% of free alcohol in the carnauba wax. There are other references in the article in which he states that there undoubtedly is a considerable per cent. of free alcohol in carnauba wax, but I find no other figures from which any approximate estimate of the amount could be obtained.

*xQ*. 273. But your conclusion depends upon the reasoning set out in the long answer just given?

*A*. As to the approximate figures of the free alcohols it does. I, of course, refer to Sturcke's article.

*xQ*. 274. I show you that particular portion of the translation of the Sturcke article which I quoted in *xQ*. 111 propounded to Dr. Stillman. Do you understand that in the proceedings there described the carnauba wax was dissolved in alcohol?

*A*. No, in the proceedings there described the saponified material is extracted with petroleum ether.

*xQ*. 275. With what do you understand the wax was "directly saponified"? *A*. By alcoholic caustic soda.

*xQ*. 276. What is the meaning in this connection of the phrase, "separated with salt"; what was separated and how was this done?

*A*. In soap, in order to separate the same from excess of alkali, the operation of salting out is employed. This will separate the soap, and other fatty bodies contained in the same, from the excess of alkali and from the solvent which is contained in the soap. In this case, the operation of salting out removes both the excess of alkali and the alcohol which was used as a solvent, for that alkali during saponification.

*xQ*. 277. It was the *soap* that was "dried" after the separation with salt? *A*. It was the soap and alcohols mixed therein.

*xQ*. 278. What substance or substances diid Sturcke dry?

*A*. He dried the total saponified mass consisting of the soda soap and of the acids in the material which he saponified together with the alcohols that were contained in the same.

*xQ*. 279. "And then the dry soap (was) extracted." How was the dry soap extracted, and what was left?

*A.* The dry soap was extracted with petroleum ether; in this article I do not see any description of the exact apparatus used. There are a number of methods that are used for carrying on this process, the principle involved in each is that, first, solvent is supplied to the material which carries away the portions which are soluble in the solvent, and this is repeated a sufficient number of times to more or less completely remove all of the matters soluble in the particular solvent used. This would leave a residue consisting of the soda soap of the acids contained in the matter originally. This original matter in this case, as mentioned on page 7 of the translation of Sturcke's article, was that part of the carnauba wax which had remained unsolved in hot ethyl alcohol during the treatment of the original raw wax; and therefore these acids would represent the acids combined in the esters which occur in the carnauba wax.

*xQ.* 280. If I understand your attitude, where the Sturcke article says "The wax was directly saponified," do you consider that the term "the wax" does not mean carnauba wax, but merely that portion of it which had formerly failed to dissolve in the hot alcohol?

*A.* In the part which I have just referred to in my previous answer Sturcke mentions that the part of carnauba wax which had remained unsolved in alcohol was converted into soda soap and extracted. Further down on the same page he states—"In the experiment with a second and third quantity of wax the digestion with alcohol was left out. The wax was directly saponified and then separated with salts dried, and the dry soap extracted." This refers to an additional experiment.

*xQ.* 281. And it was this additional experiment which is set out in *xQ.* 111 propounded to Dr. Stillman; in other words, the substance dealt with in the experiment there inquired of was the carnauba wax and not some undissolved residue?

*A.* The amounts given in the answer to *xQ.* 111 do not, as I take it, represent either one; they represent the combination of the residues unsolved in hot alcohol, and two fresh portions of the raw carnauba wax saponified, amounting in all to 2800 gramms, from which he obtains 1,550 gramms of alcohols for purposes of fractionating, in order to study their nature. There is nothing quantitative about it because he states that in the experiment with the second and third quantity of wax about 800 gramms of the original wax, which was not digestive with alcohol, was used. That second and third portion together would amount to about 1600 gramms, which, together with the other soaps obtained from previous saponifications, amounted to 2800 gramms. In this particular part of the treatise he is dealing with the substance extracted, which, by the treatment, would be the alcohols and hydrocarbons contained in the original wax, in order to get a large quantity for the purpose of fractionating and identifying various bodies contained in the same. In order to perform such fractionating experiments it was necessary to have a very large amount and for that reason Sturcke has evidently combined all of his extracted matter including that from raw wax and that from the residues after alcoholic extraction.

*xQ.* 282. That is to say, according to your views, Sturcke got about 1,550 gramms of the alcohols and hydrocrabons out of about 2800 gramms of material, and this material consisted of practically three batches, namely, one consisting of some 850 gramms of the ester residue and the other two constituting together about 1600 grams of the crude carnauba wax?

*A.* That is my interpretation of it.

*xQ.* 283. An interpretation of what Sturcke means is of course for the Court. If we assume that Sturcke's article means that the 2800 gramms was the original carnauba out of which he obtained the 1550 gramms of alcohol and hydrocarbons, this would indicate the presence of about 55% of the alcohols in the wax would it not?

*A.* If we assume that, I think your figures are correct; but it is expressly stated in summing up his work on page 3 that out of 1,935 gramms of the part insoluble in alcohol he got 1,048 gramms of extract amounting to 54.1%, and judging from that I would say that your assumption in the question is not correct.

*xQ.* 284. "The part of the carnauba wax which did remain unsolved in alcohol, about 850 g." etc. would represent the residue from what number of gramms of the original carnauba?

*A.* The amount solved out of that body was about 60%.

*xQ.* 285. In studying this matter and giving your testimony did you take into consideration the fact that the language employed is this, namely: "The total extract quantity, *from the total quantity of carnauba wax treated* (altogether 2,800 g.)"

*A.* I do not consider those figures as representing the total amount of carnauba wax treated, but that they refer more especially to the carnauba wax and the residue prepared in this particular part of the experiment, because it is stated at the beginning of the article that in one case, 1,931 g. and in another

1,957 gramms of original carnauba wax were used, and further on it is stated that two lots of 800 gramms each of original carnauba wax were used, thus making a total of 5,488 gramms, which does not correspond at all with the assumption that 2,800 gramms represents the total amount of original wax treated.

*xQ.* 286. The paragraph which you have just referred to as being near the beginning of the article begins, does it not as follows:

> "In order to obtain information about the part of the carnauba wax dissolved in boiling alcohol, as well as about the part which was not dissolved, carefully weighed quantities (about 2 g.) of the raw carnauba wax and of both the dissolved and undissolved parts thereof were saponified," &c.

He is dealing with carnauba wax obtained from an English drug store and some obtained from a Dresden drug store; and after that follows the table in which the figures as given in this translation of the material obtained from the German store appear to be 1,931 g.; of the material obtained from the English store, 1,957 g.; that the material soluble in alcohol is 1,939 g. and that insoluble in alcohol 1,935 g.; does it not appear to you that the comma in these last four figures is a mistake for the decimal period, so that the amount employed in each of the four tests was stated before to be about two gramms instead of about two thousand gramms; and is it not also the fact that in German the diacritical mark which we call a comma is the decimal point?

Before answering this question I call your attention to a paragraph a page or two further on in which Sturcke says that in order to examine still further the solubility of the carnauba wax "2,52 g." of it was treated and of this there remained undissolved "0,98 g." and a few lines below he gives the figures "0,295 g." and "0,286 g."

*A.* In calculating the percentage of myricyl alcohol from these figures the percentage given was taken as a basis, and not the actual weight of the substances used. You are correct; Sturcke evidently meant two gramms of the material or thereabouts. I had not considered it as being the small amount, I considered the amounts given as the larger amounts "1,931 g.," not regarding the comma as the decimal point. This, however, does not affect the deductions in regard to these figures, but it would change my answer to *xQ.* 285 where I referred to 5,488 gramms, because in that answer I considered these figures as the larger amounts. This interpretation of these weights actually used in this experiment, namely, 1.931 gramms, makes those figures more quantitative than I had considered them when I was figuring out the 31% of myricyl alcohol. I would think with the larger figures there was no attempt made for quantitative determinations of the amount of free alcohol in them at all or as to the total amount of alcohol; the larger figures referred to being the 2800 grams and the 1550 grams on page 8 of the translation where no decimal point is used. The object of Sturcke in making the experiments with the smaller amounts was to quantitatively determine these points, whereas his object in operating on the larger amounts was to produce sufficient of the alcohols to investigate as to their nature. The saponification of these larger amounts was most probably incomplete, whereas his alcoholic saponification of the small amount was probably more thorough and complete. It is stated that these larger amounts, namely the 800 gramms of carnauba wax and the 850 gramms of the residue which was not dissolved in alcohol, were converted into soda soap; it does not say that they were converted into soda soap by means of alcoholic caustic soda. This being the case I know from my own experience that carnauba wax cannot be completely and thoroughly saponified without the aid of alcoholic soda or potash, by ordinary methods of saponification. Therefore any deductions arrived at from these larger figures cannot be taken in a quantitative way. The object of the investigator was to secure large amounts to experiment on and for purposes of quantitative work he used the smaller amount above referred to and which was used by me in figuring out the 31%. The investigator himself has depended upon the result of his work on this smaller amount for proof of the existence of free alcohol in considerable amounts, because at the end of his work on this smaller amount he makes this statement:

> "The presence of free alcohol in carnauba wax can consequently be doubted no longer."

In addition, on page 4 of the translation he says

> "Furthermore it is demonstrated by the above determinations that free alcohol, even in considerable quantities is contained therein."

In view of this explanation I would answer *xQ*. 285 as follows: I did not use in my calculations, where I got 31% from Sturcke's figures, the larger amounts mentioned in your question. These larger amounts were converted into soda soap and since he does not mention the use in connection therewith of alcoholic soda, I consider that the percent. of extract matter obtained on these larger amounts as of no value in any quantitative deductions regarding carnauba wax. The object of the investigator in operating on these large amounts was to produce sufficient of the alcohols to more completely investigate their nature.

*xQ.* 287. Your statement as to your views of Sturcke's object and purpose and as to your own deductions and conclusions are objected to at this time as volunteered and unresponsive. But is it now your opinion that when Sturcke reported the test which he sums up by saying the "total extract quantity from the total quantity of carnauba wax treated (altogether 2800 g.) amounted to about 1550 g.," he had not previously obtained some nineteen hundred odd gramms of the extract containing the ester?

*A.* I have already referred to the answer that would have to be changed on account of the mistake as to the decimal point which in a previous question you called my attention to. That, of course, would make the figures which I gave as the original carnauba wax, amounting in one case to 1,931 gramms and in the other to 1,957 gramms, which added to the 1,600 gramms, being the two lots of 800 each, made 5,488 gramms, incorrect, and I withdraw those figures in that answer. Regarding the material operated on whereby Sturcke gets a total of 1,550 gramms of extracted matter after the saponification, that material then, I believe, included the two lots of 800 gramms each and the 850 gramms of residue after the alcohol treatment which would amount to 2,450 gramms. The original material from which he got the 850 gramms of residue by alcoholic treatment, was derived from 1200 gramms; and 850 gramms from 1200 would give 350 gramms; this amount would mean 2800 gramms of the original carnauba wax. This would appear to give a total of 1,500 gramms of alcohol from the 2,800 gramms of original carnauba wax, but it by no means follows that that amount can be depended upon as quantitative, because, as I have stated before, the two lots of 800 gramms each were not actually weighed; he says "About 800 gramms"; and, furthermore in the saponification of these materials there was not that attempt to make complete saponification that there was when he operated upon the smaller amount. Therefore I would not place any value on these figures as indicating the composition of carnauba wax in a quantitative sense.

*xQ.* 288. I believe I understand your position to be that in this experiment Sturcke had altogether 2,800 gramms of carnauba wax from which he obtained 1,550 gramms of alcohols and hydro carbons, or about 55%; but you think if he had saponified with the alcohol solution and had completed his saponification and had taken greater pains he would have obtained a higher percentage of the alcohols and hydro carbons?

*A.* He would have obtained a higher percentage, and he actually did obtain a much higher percentage in the more careful experiment where he operated on the small amount; he there obtained by the extracting of that alcohol, 60.04 per cent. of extracted matter, which extracted matter itself consisted of 78.04% of alcohol, and which residue, after the alcoholic transaction, gave 54.1% of alcohol. In other words, taking the sample of English wax whereby Sturcke gets 60.04% of extract soluble in hot alcohol, disregarding the fraction which amounts to only $^4/_{100}$, that would leave 40% of residue; after the complete alcoholic saponification and extraction of the alcohols, Sturcke obtained 78.04% of alcohols from the extracted portion; or, in other words, he obtained 47% of alcohols in the extracted portion; that is 47% of the 60 per cent. he found was alcohols. Then, in the residue, which was not soluble in water, he found 54.1% of alcohols; 54.1 per cent. of 40%, the 40% being the residue not soluble in alcohol, gives 21.6 per cent.; this added to the 47% gives 68.6% total alcohols found in the original wax in this experiment; that is, it gives at least this much. This of course may be slightly low because it is possible that the original alcoholic extraction was not carried to completion, as those operations are more or less difficult and tedious to carry to completion; and, furthermore, it is known to-day that for the complete saponification of these waxes, like carnauba and bees wax, it is not only necessary to heat them with alcoholic potash or soda, but to heat them with alcoholic potash or soda under slightly increased pressure for at least two hours, and in Sturcke's work there is no mention as to how completely this work was done. Therefore the figures he has given and the figures that are deduced from the figures which he has given, represent the minimum amount of total alcohols contained in carnauba wax, and this minimum amount, as I have before stated is 68.6%.

*xQ.* 289. I understand that you consider the particular statement of Sturcke, where he finds alcohol amounting to 55%, as being unreliable for two reasons, namely, first, because he was not intending to make a quantitative analysis and did not have that purpose in mind, and second, because his saponification was not carried out with an alcoholic solution; are these the only reasons?

*A.* I would judge anyone who was familiar with work of this kind, as Sturcke must have been, would not attempt to operate on quantities of such large amounts where he had to perform the operation of extraction, which in this case was a twofold operation of extraction, once by alcohol, in the original carnauba wax and again by petroleum ether on the saponified substances.

*xQ.* 290. Do you understand that this same test in which he says the total amount of carnauba was 2,800 gramms was one single test or the aggregate of three separate tests?

*A.* The aggregate of three separate tests.

Adjourned until Wednesday, March 20, 1907, at 10:30 o'clock A. M. at the office of Frank L. Dyer, Esq., Edison Laboratory, Orange, N. J.

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EDISON LABORATORY, ORANGE, N. J.
WEDNESDAY, March 20, 1907.

Case resumed.

Counsel present as before.

The CROSS EXAMINATION of the witness JONAS W. AYLSWORTH was resumed by Mr. MASSIE:

*xQ.* 291. Do you understand the earlier tests of the two samples, one from England and one from Dresden, and of the portion which was soluble and the portion which was insoluble, respectively, were each one single test only, or the aggregate of separate tests?

*A.* I understand that these tests represented first two separate tests.

In I he operated on 1.931 gramms accurately weighed, otherwise he would not have carried out to the third decimal, whereby he got 61.6 per cent. of extract. Second, he operated on 1.957 gramms of English wax and thereby obtained 60.04% of extract. Those two amounts represent the only portions of fresh carnauba wax operated on under these quantitative tests. The third and fourth amounts operated on, given on page 3 of the translation, were not the original carnauba wax, but as he states, 1.939 gramms of the part soluble in alcohol and 1.935 gramms of the part insoluble in alcohol.

I take it that in the third and fourth experiments where he operated on the extract portion of the residue portion after alcoholic separation, the substances which he used were those derived from his experiments I and II on the raw carnauba wax and that in order to obtain sufficient of these materials he made a further separate quantitative experiment duplicating experiments I and II, in which he used 2.52 gramms of carnauba wax and boiled the same with 750 c.c. of alcohol, thereby obtaining 38.9% of the insoluble portion and 61.1% of the soluble portion. This experiment is a duplicate of the other experiment before referred to and results in almost identically the same percentages. Following this experiment he further acted upon 10 gramms of fresh carnauba wax and repeatedly boiled it out with fresh quantities of alcohol, one-half litre at a time and he states that after the ninth time he obtained 2.95 gramms of dissolved substance in 350 c. c. and at the tenth, practically the same amount, and from these figures and from this experiment he concludes that the ester is soluble in hot alcohol to that extent. This data, together with the experiment where he used 2.52 gramms, gives us an additional method of figuring or calculating the total amount of alcohol contained in the carnauba wax.

When I made my answer to *xQ*. 272 I had not observed this additional data.

By summing up this data we are able to calculate the amount of free alcohols and total alcohols contained in carnauba wax in a different manner from that given in my previous testimony, as follows: When he operated on 2.52 gramms he got 38.9 per cent. unsolved and there must have been dissolved in the 750 c.c. of hot alcohol 61.1%, and since not over 2.95 gramms of ester dissolved in 350 c.c. of hot alcohol the solubility of the ester in hot alcohol would amount to .84 gramms per litre. Therefore there would be in the neighborhood of 25% of ester in the soluble part after extracting that hot alcohol. This leaves 36.1% for free alcohol. This percentage approximates that obtained in the other calculation and gives a further indication of the amount of pure alcohol, while it is not as accurate as the first calculation, because it is based on the solubility of the ester in hot alcohol alone. This solubility might be influenced one way or the other by the presence of larger amounts of free alcohols which are present in the extracted matter; but it is a very close approximation and agrees quite favorably with the other calculation and agrees quite favorably with the other calculation.

After making this experiment Sturcke states:

> "The ester characteristic and the presence of free alcohol in carnauba wax can consequently be doubted no longer."

I take it that Sturcke treated those 2.52 gramms in the same manner as he did the original 1.191 gramms, for the purpose of giving him sufficient quantity of residue insoluble in alcohol, and extract matter soluble in alcohol to perform the quantitative tests III and IV given on page 3 of the transslation, which I have referred to in my answer to *xQ*. . If we calculate the result of Sturcke's experiment when he uses 2.52 gramms of carnauba we get about the same result as I have given in answer to *xQ*. 271, namely, 30.3% of free alcohol, 37.7% of combined alcohols, amounting to 68% total alcohol, which would leave 32% total acids or, in other words, 30.3% of free alcohols and 69.7% of ester. The quantitative experiments made by Sturcke on these smaller amounts are reliable, but his experiments on the larger amounts are not quantitative, and no accurate quantitative deductions can be drawn from them.

My reasons for this statement are as follows: On page 5 of Sturcke's translated article he says that 1200 gramms of wax was digested out in 5½ litres of hot alcohol; in his original quantitative work he used ¾ of a litre on 2.52 gramms. This alone shows that if it was necessary to use so much alcohol in the small amount it would be necessary on this large amount to use a far greater quantity than 5½ litres. He further states that the extract 350 gramms was saponified with 25 gramms of caustic soda and the dry seived soap extracted by the petroleum ether yield together, 250 gramms of extracted alcohol, which equals 71.4% of the total matter extracted by the hot alcohol. If this experiment had been quantitative he would have gotten in this result the same figures as he did in the original quantitative experiment with the smaller amounts, namely, 78.4%. This difference is easily accounted for by the method of saponifying; he states that he saponified with 25 gramms of caustic soda, not by alcoholic caustic soda; then he took the nearly converted extracted soap left, containing the balance of 350 gramms of alcohol, extract matter obtained by hot alcohol, amounting to 100 gramms or 28.60% and combined them with the 850 gramms of the part of the 1200 gramms of carnauba wax which was not soluble in hot alcohol and, after previously converting it into soda soap, and extracting by petroleum ether in the same manner as it was done with the smaller portion, he further states that two fresh lots of wax of about 800 gramms each were taken and saponified direct without previous extraction with hot alcohol; the soda soaps from the same were then extracted with petroleum ether the fresh wax portion and the 850 gramms of the part insoluble in alcohol, altogether represent 2800 gramms of carnauba wax from which he got a total of 1500 gramms of wax alcohol, equal to 53.5%; this much notwithstanding the fact that the wax was imperfectly saponified with caustic soda, only the smaller part of the same being done with alcoholic soda as was done in his quantitative experiment referred to in the answer to *xQ*.  , where the total alcohols obtained from the wax were 68%.

In Sturcke's article he further states that:

> "In order to separate the acids contained in carnauba wax the soda salts of acids, that is wax soap, which was left after extracting with petroleum ether, was digested with alcohol. The greater part of the soap was hereby dissolved, then filtered while hot."

From this experiment we are obliged to admit that not all of the soap was soluble in hot alcohol, while, if the original saponification and extraction had been complete and quantitative, this soap would have been completely soluble in hot alcohol. This fact substantiates my opinion previously expressed in this testimony that the operations on these larger amounts were in only a very limited sense quantitative.

Further, Sturcke states on page 9 of the translation that by fractionating he obtained 45% of an alcohol having a melting point of from 86 to 86.5 degrees C., corresponding to pure myricyl alcohol. From this part of Sturcke's work, which cannot possibly be quantitative, come all these indefinite calculations and statements noted in some of the books in which descriptions of carnauba wax are given.

> All of the foregoing answer from and including the words "He made a further separate quantitative experiment duplicating I and II" is objected to as volunteered and not responsive. Any cross examination that may touch on the matters now objected to will be without waiving the objection.
>
> Defendant's counsel further notes that as this examination is being taken stenographically it will be necessary to read the transcript of the foregoing answer before the cross examination thereon, if any, can be made.

*xQ*. 292. Without waiving the objection just made I will ask you to point out the page in the translation in which Sturcke says he made a further separate quantitative experiment duplicating tests I and II?

*A*. On page 5 of the translation Sturcke says

> "In order to examine still further the solubility of the carnauba wax, 2.52 gramms of it were boiled for a

> longer period with 750 c. c. of alcohol. Of this there remained undissolved 198 gramms, equal to 38.9%."

Sturcke does not specifically state that this is a duplicate, but he treats it in the same manner as he did the lots I and II and therefore it is a duplicate.

*xQ*. 293. What I am getting at is this, do you understand that the 1,993 grams of the subcstance that was soluble in alcohol, which formed the basis of experiment III, and the 1.935 gramms of insoluble substance, whatever it was, that formed the basis of test IV, both referred to on page 3, were obtained from the test you have just now cited from page 5 which was made "in order to examine *still further* the solubility of the wax"?

*A*. I would interpret from Sturcke's article that he had derived his material, that is the insoluble part and the part which was soluble in alcohol, from either a combination of those contained in I and II on page 3 or the materials he obtained in the further experiment. I infer this because the materials that are given in III and IV on page 3 are more than those obtained by the extraction by hot alcohol in I and II, and it logically follows that he would want to operate in this experiment on at least about two gramms, since he had used that amount in the first two experiments; and in order to do so it would be necessary for him to extract fresh portions in the same manner as he did in I and II, which he did, as indicated on page 5.

*xQ*. 294. If I understand you, you assume that before Sturcke could complete the tests with the "carefully weighed quantities (about 2 g.) of the raw carnauba wax and of both the dissolved and undissolved parts thereof," he had to at least begin the tests recited on page 5 which he undertook "to examine *still further*" the subject.

*A*. I understand from these results that since he mentioned in III and IV that he used in the one case the part soluble in alcohol and in the other case the part insoluble in alcohol and since he used 1.139 in one and 1.935 in the other that it was necessary for him to extract a greater amount to produce these amounts than he had used in I and II, because the yield from these experiments was altogether somewhat over two gramms of the extracted portion and only 1.5 gramms of the insoluble part. Therefore, since he used in the experiment IV, 1.935 gramms it was ncessary for him to produce more of this insoluble part in order to use that weight.

*xQ*. 295. In speaking of that test which resulted in giving 1550 gramms of alcohol from 2800 gramms of the carnauba, in answer to *xQ*. 275 you say the saponification was made "by alcoholic caustic soda," whereas, further on (*xQ*. 286 and *xQ*. 289) you say that it was not made by an alcoholic solution. Why did you assume in the first instance that it was so made and why did you assume afterwards that it was not so made?

*A*. In my answer to *xQ*. 275 the statement as to the alcoholic caustic soda is correct, the alcoholic caustic soda was not actually used, that is, he added 25 gramms of caustic soda to the alcoholic solution of the wax, and in that answer I referred to that portion of the material. In the answers to the other cross questions you have mentioned this material together with the fresh quantity of wax which was not treated with the alcohol previously, was, as stated by Sturcke, converted into sodium soap direct, from which I infer that in this first portion there was no alcoholic soda saponification at all. So that, more correctly speaking, of this whole 2800 gramms of carnauba wax, whereby were produced 1500 gramms of alcohol, only the small portion of the extracted material produced by the alcoholic separation was saponified by the alcoholic caustic soda; but I understand from Sturcke's article that the residues from this alcoholic separation together with the fresh portions of 800 gramms each of carnauba wax, were directly saponified by caustic soda without the aid of alcohol.

*xQ*. 296. In answer to *xQ*. 271 you quote Sturcke as saying that the esters existing in the wax are soluble only to a very slight extent in boiling alcohol. Lewkowitsch says, does he not, on page 872 that:

> "Carnauba wax dissolves completely in ether and boiling alcohol; on cooling a crystalline mass of the melting-point 105 degrees C., is deposited from the alcoholic solution"?

*A*. Lewkowitsch states that carnauba wax dissolves completely in ether and boiling alcohol: from that I would interpret that he means a mixture of ether and boiling alcohol.

And he further states:

> "On cooling, a crystalline mass of the melting-point of 105 degrees C. is deposited from the alcoholic solution."

Judging from Sturcke's experiment I will consider that Lewkowitsch obtained by this solution, if he used sufficient of the boiling alcohol, and ether, a solution consisting of free alcohols and the esters contained therein and if it separated on cooling, or deposited on cooling, a crystaline mass that would, if the solvent was boiling alcohol alone, separate a mixture of alcohols and esters, but if the solvent was a mixture of ether and boiling alcohol I do not know what the solubility of the alcohols that occur in carnauba wax is in such a mixture. But the literature on the subject states that in cold alcohol, myricyl alcohol is practically insoluble, but freely soluble in hot alcohol, whereas the esters that occur in carnauba wax, as demonstrated by Sturcke are only soluble to the extent of .8 gramms per litre in hot alcohol. Without having the definte quantity of the solvent given any definite statement as to whether the crystalline mass represented all material contained in the solvent, I would not be able to more than guess on the nature of that paraticular crystalline mass mentioned by Lewkowitsch on the quotation made in your question.

*xQ.* 297. Do you assume that in the passage I just now quoted from Lewkowitsch he mixes cold ether with boiling alcohol and if so in what proportions do you assume he took those two solvents?

*A.* We cannot assume any proportions. In cases where a mixture of ether and alcohol is used the proportions may vary within wide limits and I would infer that he mixed the two together and boiled them; the boiling could not refer to boiling alcohol and not boiling ether.

*xQ.* 298. I put it to you that the position of the adjective "boiling" indicates that Lewkowitsch means either ether alone or boiling alcohol alone; otherwise he would have said "boiling alcohol and ether"; what have you to say to that suggestion?

*A.* It might be interpreted as meaning ether or it might be interpreted as meaning boiling alcohol or it might be interpreted as meaning ether and boiling alcohol, meaning in the latter case the two solvents combined in a boiling state.

*xQ.* 299. If the Court should interpret this passage as meaning that according to Lewkowitsch he found carnauba was easily soluble in boiling alcohol alone, how would you reconcile that with Sturcke's contrary report of his investigation.

*A.* The two statements absolutely cannot be compared because Strucke in his paper gives definite amounts of the solvents which he used and the results therefrom. This statement of Lewkowitsch gives no amounts and he might have used a barrel of alcohol and dissolved a gramm of the substance.

*xQ.* 300. Do you think it probable that a man of science enjoying the reputation which Lewkowitsch enjoys, if he required a barrel of alcohol to dissolve a gramm of substance would state in his text book as he has stated that the substance "dissolves completely"?

*A.* Where I mentioned a barrel of alcohol of course that is an exaggerated expression, but I know from experience that carnauba wax is not soluble in boiling alcohol, that in order to dissolve it in boiling alcohol it is necessary to have at least one litre of this boiling alcohol per gramm of substance used, the substance being carnauba wax.

*xQ*. 301. Do you think it likely that if Lewkowitsch, in order to dissolve carnauba wax "completely," had to employ a very large quantity of the solvent he would content himself with the simple assertion that the substance dissolved completely in that solvent without explaining that a large quantity of the solvent must be used?

*A*. In determining matters of solubility by chemists there is always used a very small amount of the substance in a relatively large amount of the solvent where the substance is only sparingly soluble and I consider that since Lewkowitsch makes the statement that the free myricyl alcohol contained in carnauba wax is easily removable by cold ethyl alcohol, he might also make other statements that were not properly considered or in which he is entirely mistaken. A quotation has been given in the testimony in this case regarding the solubility of myricyl alcohol which was taken from the very latest work, in German, on the subject, which makes the definite statement that myricyl alcohol is practically insoluble in cold alcohol. Since Lewkowitsch stated that it could be easily removable by cold ethyl alcohol all of his statements regarding the constitution of carnauba wax could very readily be in error, because if he believed that myricyl alcohol was removable by cold ethyl alcohol by treating carnauba wax thus, he would not remove the myricyl alcohol, and therefore his conclusion that it contained no myricyl alcohol, based on this belief, would be wrong.

*xQ*. 302. Comparing the passage you have just cited from Lewkowitsch with the one I quoted a while back, in the latter Lewkowitsch says that the entire carnauba composition is completely soluble in "boiling alcohol"; in the former passage he names the three ingredients, cerotic acid, myricyl cerotate and myricyl alcohol, and says the last named is easily removable by cold ethyl alcohol. Might not this mean that the two first named ingredients are soluble in cold alcohol, while the myricyl alcohol is not soluble and therefore can be separated out.

*A*. Not at all. The language of Lewkowitsch's book at page 874 is

> "Carnauba wax consists chiefly of myricyl cerotates and small quantities of free cerotic acid and myricyl alcohol; the latter is easily removable by cold ethyl alcohol".

When he speaks of the latter, according to my interpretation of the grammar, he means the free cerotic acid and the myricyl alcohol.

*xQ*. 303. That is, he takes these two subjects for the singular form of the verb, namely "is," instead of saying "the latter *are* easily removable"?

*A*. No, strictly speaking I should say, on account of the singular verb, that he meant the myricyl alcohol, and that the mycyl alcohol would be removable by the use of cold ethyl alcohol and from my knowledge of these substances I know that it could not be the converse of this, that the myricyl cerotate would be removed by its solubility in cold ethyl alcohol, because even in hot ethyl alcohol, the myricyl cerotate is only soluble to the extent of eight-tenths of one per cent.

*xQ*. 304. Sturcke discovered, did he not, a hydroxy acid present in carnauba wax which is cited by Lewkowitsch on page 874?

*A*. He did.

*xQ*. 305. Will you please give the combining weight of this acid?

*A*. I have figured the combining weights; the acid which Sturcke in his article calls dicarboxylic acid, he mentions as one of the components of carnauba wax, Sturcke also gives a hydroxy acid; this I have not figured the combining weight of. The combining weight of the dicarboxylic acid mentioned by Sturcke is 168. The presence of this acid would account for the high saponification number given by Lewkowitsch, as, if the carnauba wax contained for instance 10 per cent. of this acid, it would be sufficient to give carnauba wax a saponification value of 33.3; the saponification of this dicarboxylic acid being 333 approximately. This acid, in addition to the hydroxy acid mentioned and the lignolceric acid would make it impossible to calculate from saponification values the cerotic acid in carnauba wax; it would only be possible to use for the saponification value the calculations, if we knew the exact amount and nature of each acid present in the substance.

> All of the foregoing answer that refers to "dicarboxylic acid" is objected to as volunteered and not responsive.

*xQ*. 306. In the translation of the Sturcke article at next to the last page he says does he not

> "Finally I will give a recapitulation of the substances demonstrated in carnauba wax.
>
> 1. * * 2. * * etc.

7. An acid (giving its formula), an oxy-acid, or possibly its lactone (giving its formula) with a melting-point of 103.5 degrees; from this the dicarboxylic acid (giving its formula) with a melting-point of 90 degrees, was produced"?

*A*. Yes, that is correct.

*xQ*. 307. And on page 874 Lewkowitsch refers to this as "A hydroxy acid (giving the first formula given by Sturcke) or its lactone, (giving the second formula given by Sturcke)"?

*A*. That is correct.

Adojurned until Thursday, March 21, 1907, at the office of Frank L. Dyer, Esq., Edison Laboratory, Orange, N. J., at 10:30 A. M.

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Office of Frank L. Dyer, Esq., Orange, N, J.
Thursday, March 21, 1907.

Case resumed pursuant to adjournment.

Counsel present as before.

The CROSS EXAMINATION of the witness JONAS W. AYLSWORTH is resumed.

*xQ*. 308. Now will you please give us the combining weight of what Sturcke calls the oxy acid and what Lewkowitsch calls the hydroxy acid?

*A*. The molecular weight is 342. If this acid is monobasic its combining weight is the same. 342. I think this is a monobasic acid, this combining weight would give a saponficaton value of 164.

*xQ*. 309. In answer to *xQ*. 305 did you assume that in the language quoted in xQ. 306 Sturcke meant to say that the dicarboxylic acid existed as such in the carnauba wax?

*A*. Sturcke mentions this acid in the list of substances which he found and identified as present in carnauba wax and on that account I considered it to be present in the wax, but on looking back through his article I find that he produces this dicarboxylic acid from another substance in order to identify the nature of the other substance, so that this acid does not apparently occur in the carnauba wax itself.

*xQ*. 310. The apparently high saponification value given by Lewkowitsch has been cited in this case as contradicting Lewkowitsch's statement as to the smallness of the amount of myricyl alcohol present in carnauba. Would the presence of this hydroxy acid tend to reconcile the two statements by Lewkowitsch?

*A*. The presence of this hydroxy acid, also of the various other acids, found by Sturcke, also of the various alcohols found and identified by Sturcke, together with the possibilities of other bodies in carnauba wax, not identified by Sturcke, would account for the high saponification value, and for the discrepancies which are apparent when figuring the acid contents of the carnauba wax from this saponification value and for the discrepancies between the statements by Lewkowitsch of the very small percentage of free myricyl alcohol and by others of the large percentage of free myricyl alcohol.

On account of the combining weights of these numerous bodies it is impossible to figure with accuracy either the acid contents of the wax, or the alcohol contents of the wax when using the acetyl value and the saponification value. In all such figures there has to be assumed that the acid is some particular acid, or the alcohol is some particular alcohol, and unless this assumption is taken, which of course is only an assumption, since we know that carnauba wax consists of a variety of substances, there is no way of arriving at accurate figures of the total acid contents, or the total alcohol contents, except by the deductions which are drawn from Sturcke's quantitative tests before testified to in this case by me as I, II, III and IV, and the next succeeding experiment after these four. Of course, if the exact percentages of the various bodies were known and their exact formula and acidic properties, or basic properties in the case of alcohols, then it would be possible to accurately figure the total amount of acid. But if we already knew these percentages there would be no object in doing this. For instance, the presence, we will assume, of 10% of the hydroxy, which was referred to in the previous answer, would account for a part of the high saponification value given by Lewkowitsch and others, also if instead of the hydroxy acid the body were a lactone, or some of both, then that would affect the saponification value in the same way. Likewise, on the other hand, the character of the alcohols would affect the acetyl value and give a somewhat higher figure in that case than would be the case if we considered these alcohols to be entirely myricyl alcohol or these acids to be entirely cerotic acid, which, in the previous calculations made by Dr. Stillman, I understand was assumed.

Carnauba wax is a very complex substance; its entire composition has never been accurately determined in every detail. But, as to the questions involved in this suit, laying aside all questions of theory and all calculations from formulæ, the experiments made by Dr. Stillman whereby he obtained water, indicating a reaction, and whereby he found that a certain quantity of stearic acid disappeared in combination with carnauba wax, or some part thereof, are, together with my own experience during analyses and various experiments, and the quantitative experiments given in Sturcke's translated article together with the acetyl value given by Lewkowitsch and others, very conclusivie proof to my mind of the presence of considerable quantities of free myricyl alcohol in the carnauba wax, and that this myricyl alcohol reacts in the manner set forth in the patent.

*xQ.* 311. Please refer to Sturcke's experiments I and II on page 3 of the translation; I understand that if we consider these as two parallel experiments, take the average and disregard the decimal fractions; Sturcke found 60% of the carnauba wax to be alcohols and 40% to be acids. Is that correct?

*A.* No, that is not correct. My understanding of this is that the experiments I and II represent the results of alcoholic extraction because he says after this experiment:

> "Further verifications showed that the extract quantity of the part dissolved in alcohol considerably exceeded that of the raw carnauba wax and the latter in its turn exceeded the extract quantity of the unsolved part."

Then, on page 5, at the beginning of the next experiment on the 2.52 gramms, he says,

> "In order to examine still further the solubility of the carnauba wax 2.52 gramms of it were boiled for a longer period with 750 c.c. of alcohol; of this there remained unsolved .98 gramms, equals 38.9 per cent."

Since this percentage corresponds almost identically with the extract amount given in I and II, I believe that the interpretation of I and II as being the alcohol extraction is correct, although it might seem from the printed descriptions, which come before these four experiments, to mean that these portions of wax had also been saponified with alcoholic soda. I would judge more by the reading of the experiment on page 5 of the translation as to the figures and as to the amount which was dissolved in alcohol, than by the reading of the printed matter which in these German translations is not always very clear.

*xQ.* 312. In carrying out experiments I and II, which we will consider the same experiment, Sturcke took "raw carnauba" which we will assume to consist of three classes of bodies; namely, free alcohols, free acids and esters (consisting of combined alcohols and acids). What was the first step that Sturcke took?

*A.* From the interpretation of the experiment in Sturcke's article as just described in my last answer I would judge that the first steps would be to select the materials and powder them and weigh them and then extract with hot alcohol in suitable extracting apparatus.

*xQ.* 313. After he has weighed out the raw carnauba the first thing he tells us he does is saponification with alcoholic solution and caustic soda, is it not? *A.* No sir; he states that,

> "Carefully weighed quantities (about 2 g.) and the raw carnauba wax

then there is a comma, after the word "wax"

> "and of both the dissolved and undissolved parts thereof, in all four portions were saponified with the alcoholic solution of caustic soda."

He says "both the dissolved and undissolved parts thereof"; since "both" can only refer to two, since he specifically mentions the dissolved and undissolved parts thereof, I cannot see how it can be interpreted that the raw carnauba was also saponified by alcoholic potash, although I will admit that the wording is here not very clear. As I have said before, this is easily accounted for by the difficulties encountered in translating German.

*xQ.* 314. As I have already noted, the interpretation of the language is a matter for the Court, but do you understand that the four different bodies, namely, the sample of English wax, the sample of Dresden wax, the dissolved substance and the undissolved substance, were all four of them saponified together?

*A.* No, I do not so understand it.

*xQ.* 315. Do you understand that each of them was taken as a basis for a separate test, and that the first step in this test, after each body was weighed out carefully, was to saponify it with an alcoholic solution of caustic soda?

*A.* No, I do not so understand it.

*xQ.* 316. Do you understand that a carefully weighed quantity (about 2 g.) of the raw carnauba wax was not saponified with alcoholic solution?

*A.* Yes, I understand that in the cases of I and II they were not saponified at all with alcoholic caustic soda.

*xQ.* 317. Please read into the record the paragraph referred to.

*A.* (Paragraph read as follows):

> "In order to obtain information about the part of the carnauba wax dissolved in boiling alcohol, as well

as about the part which was not dissolved, carefully weighed quantities (about 2 g.) of the raw carnauba wax, and of both the dissolved and undissolved part thereof, were saponified with an alcoholic solution of caustic acid, the althylic alcohol was distilled off after addition of water, the soap jelly was precipitated with a solution of sodium chloride, then filtered, combined and extracted in a Thorn extraction apparatus with petroleum ether, volatile at 75 degrees to 90 degrees C., whereupon the extract quantities which were dried at 110 degrees, were determined."

*xQ*. 318. Do you understand that "both the dissolved and undissolved part thereof" were saponified together; or was each separately saponified?

*A*. I understand that each was separately saponified.

*xQ*. 319. Will you please assume that the passage just read by you in answer to *xQ*. 317 should be construed to mean that the raw carnauba wax was separately saponified with an alcoholic solution of caustic soda. Then, what is the next step that the Sturcke article describes in carrying forward test I and II?

*A*. I do not care to follow a line of reasoning in a matter of this kind on an assumption which I do not understand as being correct.

Adjourned until Monday, March 25, 1907, at the office of Frank L. Dyer, Esq., Edison Laboratory, Orange, N. J. at 10:30 A. M.

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ORANGE, N. J., Wednesday, March 27, 1907.

Met pursuant to agreement.

Present, Counsel as before.

The CROSS EXAMINATION of JONAS W. AYLSWORTH was continued by Mr. MASSIE.

*xQ*. 320. During our last session complainant's counsel, off the record raised some question as to the translation of the Sturcke article and you were to look into the matter more carefully; have you done so and have you considered the meaning of the passage we were examining?

*A*. Yes, I have gone over this translation very carefully with Dr. Langmuir, he reading from the original German and I following from the translation, and this translation appears to be entirely correct.

*xQ*. 321. I again call your attention to the passage quoted in answer to *xQ*. 317. What do you now understand was the first thing done to the "raw carnauba wax"?

*A*. It would appear from the wording of the translation and from the original article that the raw carnauba wax had been saponified with alcoholic caustic soda, and likewise the parts which were obtained by an extraction with hot alcohol. The interpretation of this translation in this particular is of no consequence in the calculations that I have made in the previous testimony because the per cent. of extract matter given in Experiments I and II happen to be identical with the per cent. obtained by alcoholic extraction, as is clearly stated on page 5 of the translation where the author says:

> "In order to examine still further the solubility of the carnauba wax, 2.62 gramms of it were boiled for longer periods with 750 c.c. of alcohol; of this there remained unsolved .98 gramms equals 38.9%

Therefore, if 38.9% were not dissolved, 61.1% must have dissolved, which amount is identical with the amount obtained in Experiment I. In making the previous calculations where I obtained 31.4 per cent. free wax alcohols the figure adopted for the parts soluble in alcohol was 60% and for the parts not soluble in alcohol it was 40%.

> All but the first clause of the above answer (down to the word "likewise") is objected to as volunteered and not responsive.
>
> The witness is cautioned that if he persists in answering matters not inquired about it will prolong the cross-examination indefinitely.

*xQ*. 322. Assuming, as you have done, that the raw carnauba wax consists of three classes of bodies, namely, free acids and combinations of alcohols and acids, constituting esters; upon saponification with the caustic soda the result would consist of three classes of bodies would it not, namely, the solvent employed with the caustic soda, the soaps formed by the soda and the acids (both those originally free and those that were in combination), alcohols, which latter would comprise both the free alcohols and the alcohols that had formerly been in the esters.

*A*. Asuming that the reactions of saponification were carried to perfection, that is to say that the saponification was complete and that all acids of esters were combined with the soda, then there would result the classes of bodies stated in your question, namely, free fatty alcohols, the soda soaps of the fatty acids and the solvent used.

*xQ.* 323. Assuming that the saponification has been carried out perfectly and is complete (as to which I will give you an opportunity later to express your views) I understand that all the acids would have combined with the soda and that there would be no free acids, and that all the alcohols will be free, that is, there are none left in combination with esters.

*A.* That is correct on that assumption, and assuming the carnauba wax to consist only of free alcohols, free acids and esters.

*xQ.* 324. After saponification of the raw carnauba wax what is the next step which Sturcke says he took in experiment I?

*A.* He separated the resultant soap and fatty alcohols from the solvent.

*xQ.* 325. He then had a mixture consisting of these soaps and the fatty alcohols, and upon the assumption that the carnauba wax was as already stated, and that the saponification was complete, there was nothing else but soaps and fatty alcohols left. What was his next step.

*A.* His next step was to separate the resulting soap from the water which was used in removing the alcohol solvent and then drying that soap mixture and extracting, after drying, with petroleum ether.

*xQ.* 326. I would like to follow the language of Sturcke a little more closely. After saponification he says first "The alcohol was distilled off after addition of water." As I understand that he first adds water and then distills, and that after distillation, he would have left the soaps, the fatty alcohols and the water. The next step is precipitation of the soap jelly with a solution of sodium chloride and then filtering and drying, which I understand to mean adding common salt and having the soap precipitated which gives as before the soap, the fatty alcohols and the water; and that upon filtering the soaps remain while the water and the fatty alcohols pass away; is that correct?

*A.* No, the latter part of that question is not correct. The soap and the fatty alcohols together are precipitated by the sodium chloride treatment and remain on the filter; it is, however, possible that this separation is not exactly complete as the presence of some fatty acids in combination with soda are not readily precipitated by the sodium chloride treatment.

*xQ.* 327. We have then on the filter our soda soap and the total of our alcohols (including those originally free and those that were originally in esters;) assuming always that the saponification had been complete in the first instance? *A.* Yes.

*xQ.* 328. That extraction in the Thorn apparatus, what is that, and what does it give us as the result?

*A*. The extraction by the Thorn appparatus was, petroleum ether extracted the fatty alcohols from the soap mixture; in this particular the amount of extract obtained can be only the minimum amount of the alcohols which were originally free and which were set free by the saponification, assuming the saponification was complete, because Sturcke mentioned in another part of his article the difficulty met with in performing this extraction. It is not likely that in any of these experiments his extraction of these alcohols contained in the soap mixtures was entirely complete, because the least traces of moisture, which he found later, affected this extraction by causing the soap to become jelly-like and preventing the complete action of the solvent. Assuming that the conditions of the experiment were absolutely perfect and that the extraction was carried to the utmost limits, then there would result a separation of all of the fatty alcohols present in carnauba wax from the soda soap of the acid present in the carnauba wax.

*xQ*. 329. Then, if we assume, first that the carnauba consisted of three classes of bodies named and did not have any resinous or other bodies present, and if we assume, second, that the saponification was carried out completely and also the succeeding steps were carried out to perfection, the extract matter which he obtained in test I consisted of the sum total of all the alcohols and was about sixty per cent. Is that correct?

*A*. Assuming the three steps to be carried to perfection then there would result a separation of the total amount of alcohols contained in the carnauba wax from the acids.

*xQ*. 330. Upon the three assumptions named in my previous question the total amount of alcohols in carnauba wax would be about 60% and the total amount of acids would be about forty per cent.

*A*. That would be the result obtained in experiments I and II assuming those things and assuming that we have correctly interpreted the steps followed by Sturcke.

*xQ*. 331. Now consider that the first step by Sturcke, the saponification, was not performed with a boiling alcohol solution of caustic soda and was not carried out under presseure, that would leave in our mixture not only the soaps and the free alcohols (consisting of those originally free and those set free) but also some esters, would it not? *A*. Yes, that is correct.

*xQ*. 332. After we have distilled off the solvent that contains the caustic soda and have added sodium chloride to precipitate the soaps and the fatty alcohols, what effect would this have on those esters which remain unbroken up by the saponification.

*A.* They would go with the fatty alcohols and the soap mixture.

*xQ.* 333. So that when we have filtered and dried and subjected to extraction with petroleum ether, the mass to which the petroleum ether is applied, consists of three classes of bodies, soaps and fatty alcohols and also our esters. What happens to the esters upon the petroleum ether application?

*A.* The esters would possibly be partly dissolved by the petroleum ether and the higher esters would not dissolve in the petroleum ether and would remain in the residue. By "higher esters" I mean the higher carbon compounds such as the higher carbon acids, combined with the higher carbon alcohols.

*xQ.* 334. Is it your opinion that some esters (those which you have classed as the "higher esters") do not dissolve in petroleum ether, and if so what is your authority or reason for this?

*A.* From my own experience I conclude that the esters present in the body would remain in the residue unless the petroleum ether were boiling, in which case the esters would be possibly more or less completely dissolved.

*xQ.* 335. In the passage from Sturcke read in answer to *xQ.* 317, he adds, after the word ether, "volatile at from 75 degrees to 90 degrees C" what is the significance of this phrase?

*A.* That phrase points out the particular quality of petroleum ether used. Petroleum ether comes in a number of different grades which are volatile from about 40 degrees C up to the boiling point of water and the particular petroleum ether which Sturcke used in this experiment was that grade which has a boiling point of from 75 to 90 degrees C.

*xQ.* 336. Can you tell us how petroleum ether of the grade here roughly indicated by Sturcke acts in dissolving esters as compared with petroleum ether of lower boiling point on the one hand or higher boiling point on the other? *A.* No, I cannot.

*xQ.* 337. Returning now to *xQ.* 333, assuming that some of the esters which had not been broken up by the original saponification, should be dissolved in petroleum ether along with the fatty alcohols, then the above 60% of extract which Sturcke found would consist, not of alcohols alone, but also of some esters containing acids; is that correct?

*A.* They might contain small traces of the esters, but judging from the extract quantities obtained in experiments I and II as compared with the percentage of total alcohols present as calculated from his other experiment on page 5 of the translation where he operated on 2.52 gramms, I would conclude that the unsaponified esters, if present at all, in the result of these experiments would be found chiefly in the part that was not extracted. I come to this conclusion from the following calculation of his experiment on page 5 of the translation which I have referred to, where he operated on 2.52 gramms, the calculation clearly stated is as follows:

Operating on 2.52 gramms of carnauba wax with 7.50 c. c of boiling alcohol, 61.1% is dissolved and 38.9% is undissolved. Then, in experiment IV he finds that 54.1 per cent of alcohols was separated from the part that was not soluble in hot alcohol; consequently that part which was not soluble in hot alcohol consisted of 54.1 per cent. of combined alcohols and 45.9 per cent of combined acids. Then in experiment III he found that 78.4% of alcohols was extracted from the part of carnauba wax which is soluble in hot alcohol. Therefore the part which was soluble in hot alcohol must have consisted of 78.4% of both free and combined alcohols, and 21.6% of acids. Therefore, of the 38.9 per cent. in the experiment on page 5, which was insoluble in alcohol, 21% is wax alcohols and 17.9% is acids, and of the parts soluble in alcohol, namely, 61.1%, 78.4% of which is alcohols, equals 47.9%; and 21.6% of this 61.1% was acids that were in combination in the esters contained in this part of the carnauba wax which was soluble in hot alcohol. Hence, 21% of wax alcohols in the insoluble part, and 47.9% of wax alcohols in the soluble part, equals 68.9% total alcohols in the wax and since this result, 68.9%, is very much higher than the total alcohols that were obtained in Experiments I and II, therefore I would conclude that either the saponification was incomplete and some of the esters had remained unextracted, or that some of the liberated alcohols were so locked up in the soap mixture that they themselves were not extracted by the petroleum ether. From these different experiments we find 68.9% total alcohols in the wax; therefore, there must have been 31.1% of acids in the wax. The ratio of acids to alcohols, as found in the ester by Sturcke's Experiment IV is 45.9% acid, to 54.1% alcohol; then, according to this ratio, there would be combined with the 31.1% acid, 36.6% combined alcohols, which, deducting the 68.9% would leave 32.3 per cent. of free alcohols.

All but the first clause of the above answer, down to the words "but judging," etc., is objected to as volunteered and not responsive and as prematurely immaterial.

Since this testimony is being taken stenographically defendant's counsel would desire to see the transcript before undertaking to cross-examine upon this answer, such examination, if any, being of course *de bene esse,* without waiving the objection.

xQ. 338. Please go back again to the beginning of experiment I and assuming that our carnauba wax contained, besides the three classes of bodies already named, resinous bodies and other substances. If the steps named by Sturcke be followed out, beginning with the saponification, that happens to these other bodies and what becomes of them?

*A.* Resinous bodies have generally acid properties; they would therefore be combined with the caustic soda and would remain with the soap, as a part insoluble in the petroleum ether. Other bodies which might be present would be the hydro-carbons, which would of course go with the alcohols in the petroleum ether solution. Other bodies which might be present in the lactone, which is converted by the saponification into the salt is a hydroxy acid and consequently would go with the soap.

xQ. 339. To wind up experiment I as far as we have gone, if we assume first that the raw carnauba wax contains nothing but acids and alcohols (free and also in combination with esters) and if we assume that the saponification be carried out completely, and if we assume that the subsequent steps, including extraction, be carried out perfectly, then you understand that Sturcke obtained 60% in round numbers of total alcohols and 40% in round numbers of total acids. But if you assume that there were other bodies present in the carnauba wax, then the resinous bodies will affect the total percentage in one direction and the lactone would affect it in the other direction, and the hydro-carbons would affect it in the same direction, so as to vary this percentage. And again, if we assume that the saponification was not completely carried out, some of the unsaponified esters would diminish the percentage of total alcohols found, while others might increase it. Is that substantially correct?

*A.* No, that is not substantially correct. Under those assumptions what would take place would be that, first, there would not be complete saponification, the majority of the esters would go on the side of the acid determined in the experiment second, the resinous bodies of the lactone would go on the side of the acid percentage determined by the experiment; third, the hydrocarbons would go on the side of the alcohol percentage as determined by the experiment.

*xQ.* 340. Does it not seem to you to be the fact that this Sturcke article is somewhat vague, and, considering separately his different tests we reach somewhat inconsistent results?

*A.* I consider the Sturcke article as a highly scientific production, but in all work of this kind of analyses of organic substances there is not that sharp quantitative determination possible which is possible in unorganic analyses, and that the result of none of the experiments can be taken as exactly quantitative, but they can be taken as approximate quantitative results and they show rather the minimum amounts of combined and free alcohols rather than the whole amount of the same, and the errors of these calculations are rather in favor of more alcohol being present than were found in the determinations, than the reverse.

*xQ.* 342. Please refer now to Sturcke's experiment IV. The basis of this experiment is something less than two gramms of something "insoluble in alcohol;" what does that something consist of?

*A.* That something could consist of only the esters present in the carnauba wax, because it is well known that the free alcohols and free acids are soluble in hot alcohol. It does not follow from that, that it represents all of the esters contained in carnauba wax, because the results of the experiments show that some of the esters were also in the part soluble in the hot alcohol, but it does give a fairly accurate example of the constitution of the esters that are contained in carnauba wax.

*xQ.* 343. I understand that you gather from Sturcke's article that this substance forming the basis of experiment IV consists of the bulk of the esters which are a fair sample of the aggregate esters; and that without regard to the nature and amount and combining weight of each of the different acids in those esters, or of each of the different alcohols in those esters, the aggregate combining weights of the acids as a class and of the alcohols as a class, are found by Sturcke to be from 45.9 to 54.1?

*A.* Yes sir, that is correct. That ratio of acid to alcohol would more nearly approximate the actual truth in regard to the esters than any calculations that are based on molecular formulæ.

*xQ.* 344. What do you say is the percentage of free acid or free acids in carnauba wax?

*A.* I have never determined this percentage of free acids but from the acid value given by Lewkowitsch it might be calculated, but, if so, the acid would have to be assumed to be a certain acid; therefore there is no positive way of arriving at the exact amount of free acid. In the experiments which have been

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referred to in the testimony of Professor Stillman where the determination was calculated from the amount of soda it took to neutralize the acids of carnauba wax which was rather higher than those published in the book of Lewkowitsch, these variations are most probably due to the method of determining the acid value as well as due to variations in the particular samples that were operated on.

The very latest determination of acid value of carnauba wax is given by Radcliffe in the Journal of the Society of Chemical Industry, Vol. 25, 1906, page 158. He gives the value more in accordance with Professor Stillman's determination; he gives the value of 2.9, and a saponification value of 88.3. The utter unreliability of saponification values and acid values for calculating the contents or composition of carnauba wax is indicated by this same writer, Radcliff, who gives the saponification value of the grade of carnauba wax known as Cerra, as 88.3 and for the same wax, bleached, he gives a saponification value of 33.; this indicates that there is present in the raw carnauba wax something or some acid which has a very high saponification value, whose nature is not known. Further, this same author gives an iodine value of 13.7 which is indicative of the presence of a considerable amount of some unsaturated bodies. The iodine value for myricyl cerotate should be practically nil. The iodine value for bees wax is given by Lewkowitsch as from 7 to 10.

A further example of the unreliability of saponification value in calculating the composition of carnauba wax is indicated by the high saponification value given by Lewkowitsch, page 875 for flax wax which is given as 101.51 and in the same table he gives the percentage of alcohols and hydro-carbons contained in the same as 81.32%. Hence, here we have a saponification value of 101.5 for a compound which has as much as 81.3% of alcohols and hydro-carbons, or, in other words, for an acid contents of 19% we have a saponification value of 101.5.

*xQ.* 345. In the beginning of the rebuttal proof complainant's witnesses seemed to have assumed that the alcohol in carnauba wax, or certainly the bulk of the alcohol, consisted of myricyl alcohol, and in like manner, the acid, or the bulk of the acids, consisted of cerotic acid and therefore the ester, or the bulk of the ester, consisted of those two specific bodies, and Professor Stillman figured upon this basis something like 7% of free acid. In the next place Prof. Stillman discredited Lewkowitsch's statement on the ground that various figures of the latter were inconsistent with each other and inconsistent with the reports of other writers; although during your cross examination you have stated that the presence of other bodies would tend to reconcile these inconsistencies. Lewkowitsch gives the acid value, and Prof. Stillman has stated off hand that the free acid in carnauba was between one and three per cent. In view of all these matters, and of the answer which you have just given, according to your best judgment what would you be willing to assign as the percentage of free acid or acids in carnauba wax?

*A.* The figures given for the consent of various bodies in the book of Lewkowitsch are undoubtedly accurate determinations with the particular methods used. But the presence of unknown bodies would greatly affect the value found for these constants. Since all these authorities find such a high saponification value for carnauba wax, therefore it is reasonable to suppose that there must be an acid body present in carnauba wax of very low combining weight, that is a body of low molecular weight, or possibly a body of higher molecular weight, which would be bivalent, or even trivalent in its action. It is impossible to tell whether the acid value given to carnauba wax is due to one of these unknown bodies or whether it is due to cerotic acid and in all of these calculations, it has of course been assumed to be cerotic acid. But if it were an acid having a very low combining weight, the acid values given by the different authorities would represent an extremely small percentage of free acid. Figuring the body as cerotic acid would give the maximum quantity of free acid possible, because that acid has the highest combining weight of any of the acids known to occur in carnauba wax, or at least, approximately the highest; there may be one of the other acids mentioned that is possibly higher in combining weight than cerotic acid.

*xQ.* 346. What, if anything, do you know as to the amount of these various bodies present in carnauba wax, myricyl alcohol, cerotic acid and the combining of the two latter.

*A.* There is no accurate data concerning the amount of these various bodies in carnauba wax, but there is a fairly accurate indication of the amount of free alcohols which is indicated by the acetyl value found by Lewkowitsch and others.

*xQ.* 347. There seems to be no question of the presence of free acid or acids at any rate. Assuming that the bulk of the free acids consist of something other than cerotic acid, then a comparatively small percentage would be allotted for the free acids and the percentage attributed to the acids in combination would be larger if the free acids were mainly cerotic acid?

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*A.* Yes. On account of the uncertainty of this percentage of free acid present in carnauba wax, in making my calculations for the percentage of free alcohol I have assumed that all of the acids present in carnauba wax were combined.

*xQ.* 348. Did not Prof. Stillman's titrating tests demonstrate conclusively that there was free acid present, never mind what the per cent., or what the nature, of the acid?

*A.* Yes, it did, undoubtedly.

*xQ.* 349. Professor Stillman, upon the assumption that his free acid was cerotic acid, found that there was about 7% of free acid. Is it correct to say that if his acid, instead of being cerotic acid had been a bivalent acid, Professor Stillman's test would show about one-half of that percentage, or about 3½% of free acid. *A.* That is correct.

*xQ.* 350. And if the free acid was a trivalent acid then we would take one third of seven per cent. or something over two per cent., as the amount of free acid? *A.* Yes, that is correct.

*xQ.* 351. As I recall the testimony there is no evidence of the presence of any bivalent or trivalent acid, but the evidence goes only to the extent of suggesting that these bodies may be present. In view of this and also of any other source or information or belief would you be willing to accept say 3% as the amount of free acid or acids present.

*A.* I would not be willing to accept any percentage for the amount of free acids from the evidence; but we could assume 3%.

*xQ.* 352. That is, we could assume this without doing any great violence to such evidence as we have before us, are you willing to go as far as that?

*A.* For the purposes of argument we might assume any figure. We can safely assume anything between one and three per cent., which amounts are given in the literature. There is no specific evidence as to the presence of acids of low combining weights, yet there is very strong evidence of their existence in the carnauba wax, which is indicated by the high saponification value given by the different authorities, and Sturcke's article by no means can be considered as a total quantitative, or even a total qualitative analysis of carnauba wax; he simply stated what he did find and there is no data given by which it could be inferred what other substances might be present in small amounts.

*xQ.* 353. Upon the assumption of the presence of certainly a bivalent acid and possibly other bivalent, or even trivalent, acid, are you able to say whether all of these acids (not cerotic acid) are free?

*A.* I would be unable to tell whether they were free or in combination.

*xQ.* 354. If any of these acids of the low combining weights are present in the esters does that mean that each portion of such acids would take up a larger amount of alcohol than the same amount of cerotic acid would take?

*A.* Yes, they would take up more than would be the case with cerotic acid.

*xQ.* 355. If we have determined the total amount of alcohols (both those originally free and those liberated from the esters) and if we assume the presence in the esters of some of these acids of low combining weights, would that not reduce the amount of free alcohol?

*A.* In my calculations for the amount of free alcohol the ratio of acid with alcohol found by Sturcke in experiment IV was taken in preference to any assumed values, and on the basis of that ratio, the percentage of free alcohols were calculated. Consequently the presence of bivalent or monovalent acids would have no bearing as to accounting for combined alcohol, because the actual conditions found by experiments were used in these calculations.

Answer objected to as not responsive.

*xQ.* 356. The question is, if we have determined the total amount of all the alcohols and if we assume that of the acids some parts consist of these acids of low combining weight, and that these latter acids are present in the esters, would not that result in a smaller percentage of free alcohol than if our acids were cerotic acid only.

*A.* I would not place much value on deductions arrived at in this matter, because there are to many assumptions. In experiments I and II, even assuming that carnauba wax was initially saponified with alcoholic soda and that the various steps of the process were carried on to perfection, the most that could be depended on from that experiment would be that there was present 61% total alcohols and 39% total acids. In order to figure anything further from this result it is necessary to bring in a lot of complicated assumptions and the results would be very uncertain.

Answer objected to as not responsive.

*xQ.* 357. I put it to you to consider two cases, first, we find 61 parts of total alcohols and thirty-nine parts of total acids, and assuming that the acid is cerotic acid (or other acids of the same combining weight) and that this acid unites with a certain amount of our alcohol to produce esters, leaving an easily calculable percentage of free alcohol; then assume, second, that some of this 39% of total acids consists of the acids of low combining weight which enter into the ester combination—the question is, would not those latter assumptions give a smaller percentage of free alcohol than the first assumption in this question?

*A.* In order to answer that question correctly it would be necessary to take into consideration whether or not there are not present among the alcohols some dihydric or bivalent alcohol, since Sturcke found alcohols of this nature present in carnauba wax; in order to answer your question we would have to assume that they did not exist because if they did exist they would greatly modify the results and if there existed in some percentage such bivalent acidic substances, one would just about offset the other and not knowing the percentage of either present we would have to have the question expres the assumption that these alcohols are not present or that they are present.

Adjourned until Monday, April 8, 1907, at 10:30 o'clock A. M. at the office of Frank L. Dyer, Esq., Edison Laboratory, Orange, N. J.

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ORANGE, New Jersey, July 17, 1907.

Met pursuant to agreement.

Present—Counsel as before.

The CROSS-EXAMINATION of Mr. AYLESWORTH is resumed by Mr. MASSIE:

> Defendant's counsel gives notice that under the stipulation heretofore made, he will print as part of defendant's record herein, the license agreement between the American Graphophone Company and National Phonograph Company *et al*, dated December 7th, 1896, together with some or all of the patents under which the said Graphophone Company is thereby licensed.
>
> Defendant's counsel likewise gives notice that he will read in his record in this case extracts from the Macdonald Note-books made exhibits in the companion suit No. 10 on the Macdonald Composition Patents of 1898—the entries referred to relating to the use of carnauba wax.

*xQ.* 358. I note that in your testimony you emphasize the difference between the art of molding cylinder-sound records and molded records on the one hand, and the art of molding blanks and of producing cut originals or cut duplicates on the other hand. And I understand it to be your belief that the quality and properties in which your patented composition differs from your ordinary blank composition, are of importance only in the molded record art. Is that correct?

*A.* That is substantially correct. The difference in the molding properties of the patented composition and the blank composition render the former decidedly successful for its purpose, but for the purpose of recording by cutting in the patented composition while it might be used as a blank composition, is not as desirable as the old blank composition itself.

*xQ.* 359. For the purpose of the present discussion we may regard the art of making blank cylinders, and of making records therefrom (either original records or mechanical duplicates) as one branch of the art; and the art of making molded cylinder records as another branch of the art. And comparing your patented composition with the regular blank composition, the patented composition has no superior advantages or utility over the old compositionn except for the molded record branch of the art?

*A.* We cannot at the present day regard the mechanical duplicating as one branch of the art and the molded record as another branch of the art, because the molded record at the time of its adoption, superceded the old and inferior process of mechanically made duplicates. If the molded record art were not in use and the mechanically made duplicate art were in use, then it would be a question for experimental demonstration whether the patented composition would be advantageous over the blank composition or not. It would certainly have some advantage as to the wearing, but whether the disadvantages of more imperfect cutting of the patented composition would offset the advantage of wearing, would be a matter of experimental demonstration.

*xQ.* 360. Please assume that we have your patented composition and are engaged solely with making blank cylinders to be used for making original records directly upon the phonograph. Would your last answer be the same, namely that the patented composition would have better wearing qualities and would have possibly inferior cutting property? *A.* Yes.

*xQ.* 361. Then is it not the fact that for the patented composition to be of any utility over the prior composition, it must be used in what we are now distinguishing as the molded-record art?

*A.* No, I rather think that if we did not have the molded record art and were making original records, that the improved wearing properties of the patented composition would stimulate the recording art to overcome such obstacles as are met with in recording on the patented composition, so as to realize an improved result over that which could be obtained on the present blank composition.

*xQ.* 362. It seems to me that the fact that the possession of the patented composition, assuming the non-use of the molding record art, as a stimulus to improve the method of recording by cutting, is not of present usefulness. I will, however, restate the question: Is it not the fact that if we are not dealing with the molded record art, but have your patented composition and wish to employ it in making cylinder records in any of the ways ordinarily employed before the advent of the molded record art, so far as any present developments have occurred the patented composition has no utility over the ordinary old blank composition, unless it be that of superior wearing qualities; and it is problematical whether the advantage of superior wearing quality might or might not be more than counteracted by the inferior cutting quality?

*A.* In the art of making records by cutting, it is first necessary to get the composition having the properties desired and then adapt the recording mechanism to suit the composition. All such recording mechanisms now in use are adapted to suit the blank composition, and if the blank composition was discarded and the patented composition was substituted in its place, there is no question in my mind but what the difficulties due to the greater toughness of the patented composition, would be overcome and that the patented composition would prove superior in several ways over the present blank composition; but of course, it is not so utilized, because the molded record art makes it unnecessary. If we did not have the molded record art, however, it is extremely probable that the patented composition, or some other composition having similar properties would come into use.

> Answer objected to as not responsive. The question was framed in order to exclude any conjecture as to what improvements might be made in the recording mechanism.

*xQ.* 363. Can you answer the preceding question considering only the developments that have already taken place, without referring to what improvements might be made in recording mechanism?

*A.* By improvements in recording mechanism, I did not mean to refer to new inventions in that way, but simply the adjustment of the angle of the needle and the thickness of the diaphragm to suit a harder and tougher material. I do know that the patented composition when properly filtered, which filtration by the way, is not a necessity in the molded record art, has certain decided advantages over the blank composition, due to its greater wearing properties, even when used in making masters at the present day for the molded records, because in so making the original or master records, it is necessary to reproduce the same several times in order to note the defects in the execution of the music, or in the making of the record, and in so doing with the present blank composition, the records are frequently injured; whereas, with the patented composition, they are not so susceptible of injury, owing to the greater wearing properties.

*xQ.* 364. Since the last session, have you given any further study or attention to the subject of the composition of carnauba wax?

*A.* I have not; I have been away to Europe in the meantime and on other business and have no opportunity of investigating any further into the composition of carnauba wax, other than to read over hastily the testimony which was given just previous to the last adjournment.

*xQ.* 365. It is the fact, is it not, that carnauba contains compound ethers or "esters," and that these are "wax-like"?

*A.* It is well established by all authorities that carnauba wax does contain a hard wax-like ether of cerotic acid and myricyl alcohol, but that it does not contain an ether of stearic or palmitic acid, such as is produced in the patented composition.

*xQ.* 366. Is the ether which you say is contained in carnauba wax a "wax-like *compound* ether"?

*A.* Wax-like is a very general and broad term and I do not think that compound ether already existing in carnauba wax could be strictly defined as wax-like, because it is very hard and has excessive shrinkage properties, whereas most wax-like materials are similar to bees' wax and paraffine, etc., which do not exhibit these properties. However, it is a wax, or rather belongs to the class of organic substances, known as waxes. Myricyl cerotate which is found in carnauba wax is a compound ether.

*xQ.* 367. If we take your regular blank composition and about ten to fifteen per cent. of carnauba wax, and simply melt the two and mix them thoroughly together, in your opinion, is the resulting composition correctly described by the language of any of the claims here sued on; and if so, which claims.

*A.* Although I do not pose as a patent expert, I think that the composition mentioned in claims 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 23 and 24 are not such as you refer to in your question.

*xQ.* 368. Why, and you may confine yourself to claim 7 in your answer?

*A.* Because, in this claim, which reads—

> "A composition for phonograph recording purposes, comprising a metallic soap, and a wax-like compound ether, substantially as set forth."

it is meant that the wax-like compound ether is produced in the making of the composition as set forth in the specification, and further there is no non-hygroscopic ingredient which is present in the blank composition.

*xQ.* 369. You have just stated that you do not claim to be a patent expert, and my questions have not asked you to interpret the scope and meaning of the claim. Please refer to the language of claim 8 and state whether or not, in your opinion, that language correctly describes the material made by thoroughly mixing the regular blank composition and carnauba wax when molten, but without employing the high temperature or the protracted heating?

> Counsel for complainant protests against questions of this character, which are plainly directed to matters of expert testimony as to the interpretation of the claims. The witness is a chemical expert and not a patent expert. Patent experts have already testified for both sides and could have been examined by defendant's counsel. If Counsel merely wishes to know whether a certain composition is included by the "language" of the claims without reference to the specification to explain what the language means, the question is plainly frivolous and immaterial and is objected to for that reason. The question and similar questions of this character are further objected to as having no basis in the direct examination and defendant's counsel is warned accordingly.

*A.* The wording of the claim indicates a mixture of the metallic soap and compound ether substantially as set forth in the specification, and since with reference to this particular claim, the specification mentions combining these materials in a particular way, unless that particular way were followed, the case mentioned in your question would not come under this claim.

> Answer objected to as seeking to interpret the scope of the claim and as not responsive.

*xQ*. 370. If I take, say ten or fifteen parts of carnauba wax which contains a compound ether that is a wax and which in some of your answers you say is "wax-like," and add it to say—one hundred parts of regular blank composition, by merely fusing the two and mixing them thoroughly together, is the composition so obtained "a mixture of a metallic soap and a wax-like compound ether"?

*A*. Yes, without reference to claim 7, which in your previous question was referred to, I should call such a mixture "a mixture of a metallic soap and a wax-like compound ether."

*xQ*. 371. Would you call the mixture obtained, as stated in *xQ*. 370 "a mixture of a metallic soap, a wax-like compound ether, and a non-hygroscopic ingredient"?

*A*. Provided that the temperature were not high enough to cause combination between the mixture, the wording of the question—that is—a mixture of a metallic soap, a wax-like compound ether, and a non-hygroscopic ingredient, would correctly describe the composition. In these questions, no reference being made to the temperature or method of combining these materials, which in the claims of the patent are clearly referred to, in the words "substantially as set forth."

> The last sentence is objected to as incompetent and volunteered.

*xQ*. 372. Is the mixture obtained as stated in *xQ*. 370 "a mixture of a metallic soap, a wax-like compound ether and ceresin"?

*A*. Assuming that the wax-like compound ether of your question to mean any wax-like compound ethers, and not the special wax-like compound ether of the patent, then I would answer your question in the affirmative.

*xQ*. 373. What is the thing which you regard as "the special wax-like compound ether of the patent"?

*A*. The substance which gives the composition its peculiar properties of toughness and shrinkage, and the other properties mentioned, whether it may be the added compound ether, or the product of inter-action of the added compound ether with the wax-like composition, or an entirely new compound ether formed in the composition from the free myricyl alcohol of carnauba wax, as specified in the patent.

*xQ*. 374. If you add carnauba wax to the regular blank composition, and do *not* get the peculiar properties of toughness and shrinkage, and the other properties, which you have mentioned in connection with the Aylsworth composition, during your testimony herein, I understand your position to be that although such composition would be correctly defined by the language quoted in *xQ.'s* 370–372, yet it would not be the composition called for by claims 7, 8 and 9 of your patent?

Question objected to as calling for a conclusion of law and Counsel for complainant renews his protest against the continued examination of this witness as to matters which are purely within the province of a technical patent expert.

*A.* This seems to be a patent expert question, in fact all of these questions appear to be patent expert questions, but defendant's counsel objects to my answering in the way that they should be answered by a patent expert; consequently I cannot answer these questions intelligently without referring to the exact wording of the claims and from my understanding of the claims.

*xQ.* 375. If you add carnauba wax to the regular blank composition (assuming them in the proportions of about 10 or 15 parts carnauba to 100 parts of the blank composition) and merely fuse them and mix them, is it your position that the composition so obtained would not have the peculiar properties now and formerly referred to by you as distinguishing your patented composition?

*A.* Since in your question, you mention no temperature, but simply say fused or mix the fused ingredients, I would infer that you mean not materially heating the material beyond their melting point, and in which case, the patent specification clearly states what my belief under such conditions are, where it states:

> "Unless the carnauba wax is melted beyond its melting point resulting in the reaction taking place, the composition, although harder, is very brittle and shrinks excessively and is therefore not so desirable as when the high heating is effected."

*xQ.* 376. Assume please, that we take the ordinary blank composition and add to it, another ingredient, (whether carnauba or "a hard wax", or "a wax-like compound ether"), or even still some other ingredient, from which during treatment with the blank composition a wax-like compound ether is produced; and suppose the treatment consists of the application of the temperatures indicated by your patent, continued during the times indicated by your patent; but suppose the composition resulting from this treatment does *not* have the peculiar properties of hardness and shrinkage and the other properties heretofore referred to by you. Would such composition be your patented composition?

*A.* That is more in the line of a patent expert question then a chemical question, and as such I am not particularly qualified, yet it is my opinion that if the results were not obtained and the patent specification were strictly followed that it would be through the mistakes or accidents in attempting to make the composition that such an unfavorable result would occur, provided we were using carnauba. Speaking as a chemical expert, I should say that if some other material beside carnauba were used in the same way and if we did not get the same result, it would not be in accordance with the practice of the patent.

*xQ.* 377. I had understood your testimony in previous sessions to be to the general effect that if you added carnauba to the blank composition, but did not raise the temperature materially beyond the fusing point of the ingredients, the resulting composition would not have the desirable properties sought for by your patent. In short, such procedure would not be an infringement, but your answer to *xQ.* 375 seems to be somewhat different. In your opinion, would or would not the composition so obtained have the new and desirable properties of the Aylsworth patented composition?

> Question objected to as calling for a conclusion of law and counsel again protests against this line of cross-examination, because it should properly have been addressed to the patent experts who have already testified in this case, if permissible at all. And the question is further objected to as having no basis in the direct examination. The question is also objected to as being irrelevant and immaterial, since it relates to no issue involved in this case, the proofs showing that with defendant's practice the composition was heating to a high temperature.
>
> By Mr. Massie—Complainant's counsel is requested to read the question and state wherein it calls for a conclusion of law.

*A.* It would have some but not all of the desired properties of the patented composition, as preferably made.

*xQ.* 378. As a chemist, are you prepared to say that every composition containing the regular blank composition and a wax-like compound ether, where the temperatures and times called for by the patent have been employed, would have the peculiar properties which you have attributed to the Aylsworth patented composition?

*A.* I can only answer definitely for such materials as are mentioned in the patent. There might be added wax-like compound

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ethers which would convey undesirable properties, such as the compound ethers occurring in certain fish oils and various substances which might be used in the manner mentioned in your question and without first trying them I would not be able to answer the question in such a broad general way.

*xQ.* 379. Are you prepared to say as a chemist, that every composition containing the regular blank composition and a hard wax where the compounding of the same has been accompanied by the temperatures and times, called for by the patent in suit, would have the peculiar properties which you have attributed to the Aylsworth patented composition?

*A.* No, I am not prepared to say that any such mixture would have the properties mentioned in the patent in suit, and as a chemist I could not advance any conjecture as to what the properties might be without knowing in advance the particular substances it is desired or intended to mix with the blank composition.

*xQ.* 380. Please consider the case where the ingredients (the regular blank composition and carnauba in substantially the proportions indicated by your patent) have been merely fused and thoroughly mixed, as distinguished from heating to a temperature materially higher and maintaining this temperature for a number of hours, or until all foaming had ceased. I understand you to say that in the first case the resulting composition will have some, but not all the peculiar advantages of the patented Aylsworth composition. Please state which of the advantages which you regard as peculiar to the Aylsworth patented composition would not be present?

*A.* It would have nearly all of the properties of the composition which was heated to the high temperature for a prolonged period, but it would in addition be more brittle and not such a desirable composition for the purpose of making molded records. And further, such a composition would have an excessive shrinkage, which is objectionable.

*xQ.* 381. So that for all practical purposes, the only differences between the Aylsworth composition made in the preferred manner and the composition made with carnauba not beyond its fusing point, are increased brittleness and greater shrinkage of the latter—that is, so far as the molded record art is concerned?

*A.* That is all that I now think of, and they are quite sufficient to render the preferred method and composition operative in preference to the simply mixed material at their melting points.

*xQ.* 382. Is the material simply mixed at the melting point in your opinion suitable for use in making molded records?

*A.* It might be used with a part of the advantages mentioned in the patent specification, but not so effectively or preferably as the preferred method and product mentioned in the patent.

Signature and certificate waived.

Adjourned subject to agreement of counsel.

United States Circuit Court, District of New Jersey.

| | |
|---|---|
| New Jersey Patent Company<br>*vs.*<br>Columbia Phonograph Company General. | In Equity No. 12.<br>On Letters Patent<br>No. 782,375. |

Edison Laboratory, Orange N. J.
Friday, February 22d, 1907.

Met pursuant to adjournment.

Present Counsel as before.

THOMAS A. EDISON, a witness called on behalf of the Complainant having been first duly sworn deposes and says as follows:

DIRECT EXAMINATION, by Mr. Dyer:

*Q.* 1. Please give your name, age, residence and occupation?

*A.* Thomas A. Edison, age 60, residence West Orange, N. J., occupation inventor.

*Q.* 2. What if any experience did you have in the early days of your experiments with the phonograph in connection with the duplication of records by molding?

*A.* I had a very extended experience in molding records from a master by pouring and dipping.

*Q.* 3. Pouring is the same as casting, is it not? *A.* Yes, sir.

*Q.* 4. Who was the assistant who did most of the work in those early experiments?

*A.* I had a great many assistants; a man named Schultz-Berge and a man named Payne and others who I do not recall now.

*Q.* 5. At that time how perfect were the molds from which you expected to make duplicates?

*A.* The molds were perfect.

*Q.* 6. As perfect as now?

*A.* I think they were as perfect as they are now.

*Q.* 7. When was it that these experiments were made?

*A.* About 1889 or 1890.

*Q.* 8. At that time the ordinary blank composition that is now used was well known, was it not? *A.* Yes.

*Q.* 9. And that blank composition was as perfect then as it is now? *A.* About the same, I think just the same.

*Q.* 10. The blank composition was the same then as it is now?

*A.* Yes, sir.

*Q.* 11. Did you ever attempt in these early experiments to make duplicates from the blank composition by casting?

*A.* Yes, sir.

*Q.* 12. Did you succeed in those experiments?

*A.* Yes, we made some.

*Q.* 13. What difficulties were encountered in that work?

*A.* The trouble was the unequal contraction, with the poor surface and with some parts of the records sticking to the mold, and bubbles, so that the number of the records which were good compared with those which were not, was very small.

*Q.* 14. These troubles then were due principally to the material used and not to the process?

*A.* Yes, due to the materials.

*Q.* 15. Did you attempt to cast records of any other material than the blank compositions?

*A.* Yes, we tried all kinds of experiments with the blank composition in which other ingredients were incorporated, and also compositions which did not have any of the compositions of the ordinary blank.

*Q.* 16. That is to say, as I understand you, you made experiments with entirely new compositions as well as experiments with the blank composition, modified by the addition of other ingredients? *A.* Yes, sir.

*Q.* 17. Do you remember what materials you attempted to use in connection with the blank composition?

*A.* Yes, we added all kinds of waxes and gums and things like that, and non-soluble materials which would go into the form of an emulsion.

*Q.* 18. In those attempts to modify the blank composition so as to fit it more perfectly for the making of molded records, did you ever use carnauba wax in connection therewith?

*A.* I do not remember positively whether I used carnauba or not, but if I did it was not a success; if it had been a success, it would have made an impression on my mind.

*Q.* 19. Do you recall how long these experiments continued, in which you attempted to make molded records by casting?

*A*. A very long while, several years. We were working on two processes to see if we could not make a cheaper and better duplicated record than what we were making by the mechanical process, one of the processes being pressing the material while in a plastic state against the record within the cylinder, and the other was to melt the material and cast it in the mold; we went from one to the other; as we would get bad results from the casting process we would then take up and try to cheapen down the present process; and then I would get other ideas and try the molding or the casting process again, and we changed from one to the other; tried to get some kind of a process which was more expeditious and cheaper and better than the mechanical duplicating process then in use.

*Q*. 20. In the casting process what was the great difficulty that you always met with?

*A*. One of the greatest difficulties as I remember it was the formation of bubbles and the unequal shrinkage, bad surface, sticking to the mold, and of course hardness was what we wanted, but we would be satisfied with no greater hardness than that of the blank composition if we could get good results in molding.

*Q*. 21. These troubles then with the casting process all narrowed down to the material? *A*. Yes.

*Q*. 22. Did you give up the casting process?

*A*. No, I did not give it up, as I always experimented with it; but finally I had so much to do that I turned it over to Mr. Aylsworth to see whether he could not find a good economical compound.

*Q*. 23. The pressing process to which you have referred is the one that is described in your patent, No. 713,209 of November 11, 1902, is it not? *A*. Yes.

*Q*. 24. And the casting process that you refer to is described in your patents No. 667,202 and No. 667,662, of February 5, 1901, is it not?

*A*. That describes one of several that I used.

*Q*. 25. After you turned this casting problem over to Mr. Aylsworth did he succeed in solving the difficulties? *A*. Yes, sir.

*Q*. 26. Did he succeed in making a material that overcame the difficulties which you had encountered? *A*. Yes.

*Q*. 27. Did you know at the time what this material was that he made?

*A*. No, I didn't pay any attention to it; it went right into commercial use and I never knew exactly what it was.

*Q*. 28. How extensive was the commercial success of the molding or casting process after Mr. Aylsworth had made his composition?

*A.* It was a very great success commercially speaking and also it was better.

*Q.* 29. With respect to the molded record art, would you regard the discovery of Mr. Aylsworth of this composition as an important contribution?

*A.* Yes, very important; it was the one thing that was wanted to make the art a success.

*Q.* 30. If the only composition known in the art was the blank composition, would the art in your opinion have developed to its present proportion?

*A.* No, I don't think it would, and I don't think anybody could make the blank composition a success.

*Q.* 31. When did you first have knowledge of Mr. Aylsworth's patent in suit? *A.* The day before yesterday.

*Q.* 32. You then saw for the first time what Mr. Aylsworth's patent was?

*A.* That is the first time I ever read the patent or knew what the exact composition was.

*Q.* 33. Were you or not surprised to find that the commercial results were secured by the use of carnauba wax?

*A.* Yes I was surprised, but I was particularly surprised at the way he got the results by the use of carnauba.

*Q.* 34. That is, as I understand you, by the prolonged heating at a high temperature?

*A.* Yes, by the prolonged heating at a high temperature which evidently produces some reactions which are beneficial and which would not be beneficial if there was not this long heating. In other words, this little trick appears to have solved the question.

*Q.* 35. I suppose you have been familiar with carnauba wax for a long time?

*A.* Yes, I have known about it for years.

*Q.* 36. Did you ever use carnauba wax in your regular output?

*A.* Yes, I think we did years ago.

*Q.* 37. Do you recall whether the very earliest records made were formed of a composition of carnauba wax and ceresin?

*A.* Yes, I think we made some records with that, but those were original records and not duplicates.

*Q.* 38. What are the principal peculiarities of carnauba wax as a molding material as you observed it?

*A.* Carnauba wax as it comes in commerce is a mixture of resins and waxes and other compounds and has an enormous shrinkage capacity and, after pouring it, on solidifying, it cracks in all directions and shrinks enormously and is very hard.

*Q*. 39. Would you be able to tell from your general chemical knowledge and your familiarity with the manufacture of phonograph compositions, without independent experiments, that carnauba wax would be miscible with the blank composition?

*A*. No, you would have to try the experiments. There are lots of material, wax-like and resin-like, which are not miscible with one another, they segregate out; they do not make perfect mixtures.

*Q*. 40. And in this art, as I understand it, it is necessary to have a homogeneous composition? *A*. Yes, sir.

*Q*. 41. Can you mention off-hand any materials that you have found from your experiments do not mix or become miscible with the blank composition?

*A*. Yes, shellac, for instance, does not mix with wax; asphalt also.

*Q*. 42. In view of your familiarity with the peculiarities of carnauba and particularly its excessive shrinkage and the fact that it warps badly, could you foretell that even if it was miscible with the blank composition, its addition to the blank composition would give the resulting combination of desirable molding properties?

*A*. You could not tell anything about it; no person can tell anything about mixtures of waxes, because the waxes themselves are mixtures, and the chemistry of waxes is not well known, and of all the waxes I know of I think the chemistry of carnauba is the least known and has been very little investigated. It is absurd to say that you could pre-determine the characteristics of a mixture of many different kinds of fatty acids with resins; it can only be obtained by experiments, and then an infinite number of results will be had, according to how they are made, with regard to temperature and the length of time they are subjected to heat.

*Q*. 43. Then you would not regard it as an obvious expedient to use carnauba wax in connection with the blank composition for the purpose of increasing its hardness and giving it desirable molding properties?

*A*. If one knew it was miscible he might think it would harden it, but as far as putting it in with another compound and the result being capable of producing perfect effects by casting processes, he could not possibly know such a thing except by actual experiments.

*Q*. 44. In view of the fact that in the manufacture of the blank composition it has been the practice for years to maintain the heat in the neighborhood of 450 degrees until foaming ceases, would you regard it as an obvious expedient, when carnauba is added to the blank composition, to maintain the heat for several hours at that temperature?

*A.* I don't see that it would be possible for anybody to know that they had to do this to produce good results. This result is purely a question of many, many experiments, or accident.

*Q.* 45. I direct your attention to your patent No. 404,582 of October 18, 1892. Does this patent describe any materials for use in casting?

*A.* Yes, it does; it speaks of wax, or wax-like material, and resin, and plaster of Paris.

*Q.* 46. Would any of these materials be successful for the practice of the art at the present time?

*A.* No, I don't think so. There is no doubt that with some of them records could be made, but the percentage of good records would be too small.

*Q.* 47. I direct your attention to your patent No. 406,576, of July 9, 1889, and call your attention to the reference therein on the first page to the use of carnauba wax. What was this wax employed for?

*A.* The carnauba wax was employed to increase the shrinkage, because asphalt, when we pour it in a mold, does not contract enough to permit it being pulled out, and I added carnauba wax to the asphalt for the purpose of causing the whole to shrink sufficiently to permit it being pulled out of the mold.

*Q.* 48. Can you state whether the blank composition possesses sufficient shrinkage for the purpose of this art?

*A.* Yes, it does. The amount of shrinkage need not be very great, about one thousandth or two thousandth of an inch is quite sufficient.

*Q.* 49. So that with the present art there is no necessity of increasing the shrinkage of the blank composition if that could be used? *A.* No.

*Q.* 50. I call your attention to your patent No. 713,209 of November 11, 1902, before referred to, which describes the pressing process and ask you if any of the compositions or materials mentioned in this patent would be suitable for the molding art at the present state? *A.* No; I do not think so?

*Q.* 51. As I understand this patent, these are all materials in which the attempt was made to produce a composition that would be harder than the blank composition? *A.* Yes, sir.

*Q*. 52. And you attempted to do that by the addition of fine precipitates? *A*. Yes.

*Q*. 53. Did the idea of adding carnauba as a possible hardening material, instead of the fine precipitates, occur to you?

*A*. No, sir, I do not think it did; if it had I would undoubtedly have mentioned it in this patent.

Further taking of testimony was therefore adjourned until Saturday, the 23d day of February, 1907, at 10 o'clock A. M. at the Edison Laboratory, West Orange, N. J.

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EDISON LABORATORY, Orange, N. J.,
SATURDAY, February 23, 1907.

Met pursuant to adjournment.

Counsel present as before.

> Defendant's counsel enters timely objection to question 42 as without basis in the previous testimony of the witness.

CROSS-EXAMINATION, by Mr. MASSIE:

*xQ*. 54. In your answer to question 5 you say the molds which you had in the early days were perfect? *A*. Yes, sir.

*xQ*. 55. Why was it supposed to be necessary to split the molds as stated in one of your early patents?

> Objected to as immaterial and irrelevant.

*A*. To get the record out; we thought it necessary.

*xQ*. 56. In answer to questions 11 and 12 you say that in those early experiments in attempting to make duplicates from the blank composition by casting, you made some; at what temperature were those castings made? *A*. I do not remember.

*xQ*. 57. In answer to question 19 you speak of trying to cheapen down the pressing process; did you succeed in getting a pressing process that gave you good results, but that was not sufficiently cheap?

*A*. We sometimes got some very fine records but the proportion of goods records to the bad ones was so small that it was out of the question to make them commercially.

*xQ*. 58. My question was as to the meaning of the word "*Cheapen.*" *A*. Cost of product, I mean.

*xQ*. 59. Because such a large proportion were broken or were unsatisfactory? *A*. Were bad.

*xQ*. 60. In answer to question 20 you speak of the casting process and your experience in that specific process; in your experiments was the mold heated before hand or how was that?

*A.* I do not remember exactly.

*xQ.* 61. Was the molten material poured into the top of the mold or was the mold dipped into the material, or how was that?

*A.* Generally dipped, as the pouring made streaks.

*xQ.* 62. Do you remember whether or not the temperature was maintained at the dipping or how was that?

*A.* We simply melted the material and as soon as it was molten we would dip the mold into the material.

*xQ.* 63. In answer to question 22 you say that you turned the subject over to Mr. Aylsworth to see whether he could not find a good economical compound; does that mean that you already had a good compound that was not economical?

*A.* I have already stated that we had a compound which sometimes would give a good record, but so many of them were bad that it was not economical and I wanted Mr. Aylsworth to find a compound that would give such a percentage of good ones that it would make the product a commercial success; that our losses would not be so great as to eat up all the gain.

*xQ.* 64. Is the process described in your patent No. 713,209 (question 23) a good process for pressing records?

*A.* Yes, a very good process.

*xQ.* 65. But how about it for the same composition for casting a record?

*A.* You can use composition in pressing that you could not use at all in casting; for instance you could use material that would not melt but would soften to permit a pressing.

*xQ.* 66. Are we to understand that the composition and process set out in your patents No. 667,202 and No. 667,662 (*Q.* 24) will give some good cast records, but the percentage will be small?

*A.* Yes, they will give some good records; it is entirely a question of the material, its characteristics.

*xQ.* 67. But I understand that the percentage of poor records would be so great that those two patents are not commercially satisfactory, is that correct?

*A.* Well that depends. The process itself is all right provided the compounds are all right, but the compounds therein spoken of did not give enough good records to compete commercially with the process we already had, working mechanically. We were competing against a commercial process already in vogue and in use and unless we could produce something better and get more for it or produce it cheaper, we could not compete.

*xQ.* 68. The commercial process already in use means the mechanical duplicating that was formerly employed? *A.* Yes sir.

*xQ*. 69. In your answer to question 38 you are speaking of carnauba wax without any other substance being added to it when you say that it cracked in all directions, does not solidify?

*A*. Yes sir, I am.

*xQ*. 70. Do you regard carnauba wax as a "wax"?

*A*. It is called a wax, but it is a mixture of resins and waxes.

*xQ*. 71. Do you regard shellac as a wax? *A*. No.

*xQ*. 72. Do you regard asphalt as a wax?

*A*. No, it is not called a wax, although some of the members of the family are quite waxy.

*xQ*. 73. As a rule are *waxes* miscible with the blank composition; I mean the metallic soap mixture used for making blank cylinders for phonographs.

*A*. I could not answer that question, whether all waxes are miscible; I think most of them are, but if a new wax should come in the market, it would be hard to say whether it is miscible or not until you had tried it, because it might be misnamed as a wax and not be a wax at all; paraffine is not a wax but it is wax-like.

*xQ*. 74. How long has carnauba wax been known by persons in the talking machine art?

*A*. Oh, that must have been known from the earliest time in the talking machine art.

*xQ*. 75. If one in the talking machine art knew that carnauba wax was miscible with the ordinary blank composition, that is the composition for making the blank cylinder, would he assume that he could use it to harden the blank cylinder composition?

*A*. He might and might not according to his experience. Hardening is not the only thing to be solved in the use of carnauba wax.

*xQ*. 76. Confining ourselves for the present to hardening only, if this mechanic skilled in the talking machine art knew that carnauba wax was miscible with the blank cylinder composition, would he not know that carnauba wax would harden that composition?

*A*. I don't know. Carnauba melts at a high temperature and some waxes at the temperature of the melting of carnauba would decompose and the result would be softer than when he started. The subject is too complicated to be able to theoretically determine beforehand what is going to be the result, there might be inter-actions that are not known; it depends on the composition.

*xQ*. 77. Does the blank composition used by the Edison Phonograph Works decompose at the melting point of carnauba?

*A.* I suppose some of it does decompose; I think when carnauba is put into that mixture chemical reactions take place. I do not know what they are, but I am pretty sure they do, as evidenced by the formation of gas and a lot of other products that are odoriferous.

*xQ.* 78. My question did not assume that carnauba was added; I merely asked whether the blank composition itself would decompose at the temperature at which carnauba would melt?

*A.* Yes, it distills and decomposes; you can keep it for a long time at a certain temperature, or the temperature we use it at and it will gradually blacken and decompose until it gets jet black.

*xQ.* 79. Do you know what reactions are taking place; I am speaking only generally; do you know what happens to the blank composition if it is kept at the temperature at which carnauba melts?

*A.* Oh, no, no one knows such things. The chemistry of waxes is very little known; they are most complicated mixtures of high atomic weight.

*xQ.* 80. Is carnauba miscible with asphalt?

*A.* Yes, it is not perfectly miscible, but you can get it in combination.

*xQ.* 81. Can you name any wax or any waxes with which carnauba is not miscible?

*A.* I don't remember any just now, but I suppose there are certain waxes which it is not miscible with, that decompose at a low temperature.

*xQ.* 82. In your direct testimony you have spoken of attempts to make cast records by processes and the use of compositions specified in your testimony and you say that the results were not commercially satisfactory; do you remember anything about the duration of the time during which the temperature was kept up, in attempting to do this work?

*A.* We generally melted the base compound and then added the other ingredients and then when they were liquid enough we used them.

*xQ.* 83. You used them as soon as they were liquid enough without further maintaining the heat? *A.* Yes, sir.

*xQ.* 84. And in the same manner with regard to all your attempts to make satisfactory cast records, I understand that the mold was lowered into the molten material and raised as soon as enough of the composition had adhered to it?

*A.* Not in all cases.

*xQ*. 85. What other methods were employed?

*A*. We poured them in, dipped them and raised the liquids up into the molds.

*xQ*. 86. When was it that you turned over to Mr. Aylsworth the problem of finding a good economical compound for making cast sound records? (*Q*. 22.)

*A*. I cannot tell until I look up my records.

> Counsel for complainant states that this information will be furnished to defendant's counsel by Mr. Aylsworth, who is at present being examined.

RE-DIRECT EXAMINATION, by Mr. Dyer:

*Q*. 87. In view of the objection by counsel for defendant I will ask you to read question 42 of your direct testimony and state whether any statement is made therein that is in any way suggestive to you? *A*. (Mr. Edison reads question 42.)

*Q*. 88. Have I misled you in any way or said anything that is not correct? *A*. No, I knew all that before.

Signature and certificate waived.

Adjourned until Monday, February 25th, 1907, at the office of Frank L. Dyer, Orange, N. J.

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Orange, N. J., Thursday, February 28th, 1907.

Met pursuant to agreement.

Present—Counsel as before.

Complainant's counsel offers in evidence copies of the following patents as exhibits for the Complainant:

Patent to Edison, No. 200,251, dated February 19, 1878, and the same is marked "Complainant's exhibit, Edison Patent, No. 200,251."

Patent to Reynolds, No. 287,156, dated October 23, 1883, and the same is marked "Complainant's Exhibit, Reynolds Patent, No. 287,156."

Patent to Tainter, No. 341,287, dated May 4, 1886, and the same is marked "Complainant's Exhibit, Tainter Patent, No. 341,287."

Patent to Berliner, No. 372,786, dated November 8, 1887, and the same is marked "Complainant's Exhibit, Berliner Patent, No. 372,786."

Patent to Harrington, No. 392,953, dated November 13, 1888, and the same is marked "Complainant's Exhibit Harrington Patent, No. 392,953."

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Patent to Edison, No. 393,968, dated December 4, 1888, and the same is marked "Complainant's Exhibit Edison Patent, No. 393,968."

Patent to Harrington, No. 397,856, dated February 12, 1889, and the same is marked "Complainant's Exhibit Harrington Patent, No. 397,856."

Patent to Harrington, No. 399,265, dated March 12, 1889, and the same is marked "Complainant's Exhibit Harrington Patent, No. 399,265."

Patent to Edison, No. 406,408, dated April 2, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 406,408."

Patent to Edison, No. 400,649, dated April 2, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 400,649."

Patent to Edison, No. 406,050, dated April 2, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 406,050."

Patent to Edison, No. 406,570, dated July 9, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 406,570."

Patent to Edison, No. 406,571, dated July 9, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 406,571."

Patent to Edison, No. 406,576, dated July 9, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 406,576."

Patent to Edison, No. 471,759, dated November 12, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 471,759."

Patent to Edison, No. 430,274, dated June 17, 1889, and the same is marked "Complainant's Exhibit Edison Patent, No. 430,274."

Patent to Edison, No. 430,570, dated June 17, 1890, and the same is marked "Complainant's Exhibit Edison Patent, No. 430,570."

Patent to Heysinger, No. 440,155, dated November 11, 1890, and the same is marked "Complainant's Exhibit Heysinger Patent, No. 440,155."

Patent to Harrington, No. 464,476, dated December 1, 1891, and the same is marked "Complainant's Exhibit Harrington Patent, No. 464,476."

Patent to Edison, No. 404,582, dated October 18, 1892, and the same is marked "Complainant's Exhibit Edison Patent, No. 404,582."

Patent to Edison, No. 488,191, dated December 20, 1894, and the same is marked "Complainant's Exhibit Edison Patent, No. 488,191."

Patent to Wassenich, No. 405,910, dated October 3, 1893, and the same is marked "Complainant's Exhibit Wassenich Patent, No. 405,910."

Patent to Lioret, No. 528,273, dated October 30, 1894, and the same is marked "Complainant's Exhibit, Lioret Patent, No. 528,273."

Patent to Berlinger, No. 548,623, dated October 29, 1895, and the same is marked "Complainant's Exhibit Berliner Patent, No. 548,623."

Patent to Petit, No. 689,117, dated December 17, 1901, and the same is marked "Complainant's Exhibit Petit Patent, No. 689,117."

Patent to Edison, No. 713,209, dated November 11, 1902, and the same is marked "Complainant's Exhibit Edison Patent, No. 713,209."

Patent to Jones, No. 727,960, dated May 12, 1903, and the same is marked "Complainant's Exhibit Jones Patent, No. 727,960."

DELOS HOLDEN, a witness called on behalf of the complainant, having been first duly sworn according to law, testified as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. Give your name, age, residence and occupation?

*A.* Delos Holden, age 35, residence Orange, N. J., occupation, solicitor of patents.

*Q.*2. Did you ever, in connection with Mr. Aylsworth or others witness any experiments with various phonographic compositions and if so when was it?

*A.* I did. Beginning on December 27, 1906, I witnessed the preparation of five compositions, which were made up by Mr. Dodd; the ingredients which entered into each of these compositions were weighed out by Mr. Dodd in the presence of myself and Mr. Aylsworth. We also witnessed the manufacture of the composition from the ingredients, taking temperature readings quite frequently and keeping a general oversight of the entire process of manufacture. I also witnessed the molding of phonograph records from four of these compositions, and the first inspection which was given them. These experiments consumed about two weeks altogether.

*Q.* 3. You say that five compositions were made; were these designated in any particular way.

*A.* They were designated as A, B, C, D and E.

*Q.* 4. Take up composition A and state what its ingredients were and how it was made.

*A.* The ingredients of this composition were 1,400 grams of sheet aluminum, 172 pounds of sal-soda, 3,616 grams of caustic soda, 800 pounds of stearic acid. The sal-soda was placed in a steam jacketed kettle and about 20 to 30 gallons of water added; the caustic soda and aluminum were then added and steam turned on; the solution boiled vigorously for about half an hour and this was kept up until the metal was all dissolved. The stearic acid was placed in a large aluminum kettle, fire was started under it and the acid was melted. This melted acid being at a temperature of 285 degrees F., Mr. Dodd began to add the alkaline aluminum solution, a dipperful at a time; the hot stearic acid would hiss and steam as each dipperful went in and foam, so that it was necessary to wait between dipperfuls in order for the agitation to decrease before adding another dipperful, so that it took half an hour to add the first half of the solution, when the temperature was 250 degrees F. At the end of one hour the temperature was 380 degrees F. About one hour and fifteen minutes was occupied in adding this solution and the temperature was then 420 degrees F. After the solution was all in a thick white foam covered the surface to a depth of about two inches. The temperature was maintained for about an hour and a half at 440 degrees F, at which time the foam had disappeared. The wax was then ladled from the kettle into a large copper pail from which it was poured into cooling pans. As soon as the top of the wax in the pans was sufficiently hard Mr. Aylsworth and I placed our initials in the wax so as to identify the cakes.

The ingredients for a second batch were then weighed out by Mr. Dodd exactly as before, the same weight of each ingredient being used.

This wax is a very hard, light-colored wax and was called "Hard Regular" or "Composition A"; it formed a basis for the manufacture of the four different compositions from which the records were made.

*Q.* 5. Describe Composition B and state how that composition was made.

*A.* Composition B was made on December 28, 1906, and was made as follows:

Mr. Dodd weighed out 450 pounds of Composition A and placed it in a large kettle under which there was fire, melted the composition and brought it to a temperature of 440 deg. F.; he then added 94 pounds of ceresin. The ceresin was entirely melted in about eight minutes and the temperature of the mass was then 390 deg. F.; there was a little foam produced by the ceresin and the mass was cooked for sometime; it was then ladled out, filtered and carried to the dipping tank in which records were made from it when the temperature had fallen sufficiently low. I understood from Mr. Dodd and Mr. Aylsworth that this composition was the regular blank composition, and it was brown in color.

*Q.* 6. Now, please take up Composition C and state how it was made?

*A.* Composition C was made on December 31, 1906. Mr. Dodd weighed out 433.1 pounds of Composition B, this was placed in a large kettle and melted; 72.5 pounds of carnauba wax were added to the melted Composition B, whose temperature was then 350 deg. F.; the carnauba wax was all melted in ten minutes and the temperature was then 310 deg. F. When the carnauba wax was added, there were very few slight patches of foam formed and it could hardly be called foaming as it did not cover the surface at all, but only appeared in isolated spots. The temperature was maintained at about 320 deg. F., and no foaming took place except as I have indicated. The cooking occupied about two hours, and the composition was then ladled out and put in the dipping tank, and when the temperature had dropped to 290 deg. F. the making of the records began.

*Q.* 7. Now please consider Composition D, and state what it was composed of and what process was followed in its manufacture?

*A.* Composition D was manufactured on January 2d, 1907; 412.5 pounds of Composition A were placed in a large kettle and melted; when the temperature of 400 deg. F. was reached 57.6 pounds of carnauba wax were added; the temperature was then run up as high as 470 deg. F., falling a few minutes later to 460 deg. F. The foaming was remarkable, as the foam was at least four or five inches deep on a depth of about 12 inches of wax, the average depth of which was really less because the bottom of the kettle was rounded and the depth was measured in the deepest part. The foaming continued several hours; the material was cooked five hours and forty-five minutes at temperatures ranging from 440 deg. F. to 470 deg. F., and until all foaming had ceased; 70.5 pounds of ceresin were added after cooking for two hours and a quarter. Five pounds of lamp-black were added after the material had cooked two hours and a half.

*Q.* 8. Now take up Composition E and state what ingredients were used and what process was followed in its manufacture.

*A.* Composition was manufactured on January 3d, 1907, by taking 462 pounds of composition C, placing it in a heated kettle and melting it. The wax was brought to a temperature of 450 deg. F. and held at this temperature about two and a half hours, when four pounds of lamp-black were added. The wax was then cooked two and a half hours longer at temperatures ranging from 450 deg. F. to 460 deg. F. The foaming was similar to that which took place in the manufacture of Composition D.

*Q.* 9. Did you witness the molding of records from these four compositions?

*A.* Yes, I witnessed the molding of records from each of these Compositions B, C, D, and E. The molding of Composition B took place on December 28, 1906, the operation being in charge of Mr. Nehr, and the same crew of workmen did the molding from all of these compositions, and the temperatures and conditions were uniform.

Composition C was molded on December 31, 1906.

Composition D was molded on January 7, 1907.

Composition E was molded on January 8th, 1907.

The molding was all done in the presence of Mr. Aylsworth and myself.

*Q.* 10. So far as you could judge were the operations the same with all the Compositions?

*A.* Yes, the effort was made to perform the operation in an identical manner, and it was so carried out.

*Q.* 11. How many records were molded from Composition B?

*A.* One hundred and three records were molded from this Composition.

*Q.* 12. How many from Composition C?

*A.* One hundred and one.

*Q.* 13. How many from Composition D?

*A.* Ninety-nine.

*Q.* 14. How many from Composition E?

*A.* One hundred and three. The idea was to have 100 molded from each lot, but there were a few extra ones molded except in the case of Composition D, where there was a miscount.

*Q.* 15. After these records were molded what became of them?

*A.* They were placed upon the cores until they should become hard, and were then removed and placed on a peg tray. They were then turned over to Mr. Sturm for inspection, with the exception of thirteen of the Composition C records, which were found to be cracked on the cores so that there was no use in sending these to Mr. Sturm as they were obviously worthless.

*Q.* 16. Were precautions taken to keep the different lots separate, so that they would not be mixed up?

*A.* It was impossible for them to be mixed, as I recollect it, because they were tested on different days. But in any event they were very carefully watched to see that they should not become mixed either with each other or with the regular stock of the National Phonograph Company.

*Q.* 17. Did you witness the inspection of these several lots of records by Mr. Sturm or his subordinates?

*A.* Yes, I watched them edged by the edging machine, and I also watched them as the white lettering was put on, and when they were inspected, and when they were given the visual inspection.

*Q.* 18. Was the inspection in Mr. Sturm's department made by the same employee in each case? *A.* I believe it was.

*Q.* 19. Was this edging performed by the same employees?

*A.* That is my recollection.

*Q.* 20. I understand that in Mr. Sturm's department certain of the records in each lot were rejected as being imperfect; did you examine those discarded records?

*A.* Yes, sir, Mr. Aylsworth and I went over them together and saw that they were properly rejected.

*Q.* 21. Were any special instructions given to Mr. Sturm regarding the inspection of these records?

*A.* Mr. Sturm was directed by Mr. Aylsworth in my presence, and also by me to have the test of all the records uniform and alike and to have the same workmen and girls do the edging and inspecting, so that the records would be subjected to exactly the same conditions and tests.

*Q.* 22. After Mr. Sturm had finished his inspection of the records did you examine his reports?

*A.* Yes, I examined them and checked them up to see that the figures were correct. I stood by while the young ladies made the final inspection and they had blank tickets in which they noted the various defects and also the number of good records; the good records were separated from those which were rejected and were placed in boxes having covers while the bad records were put back on the peg tray and I noticed that the number of good records corresponded with the number so indicated on the ticket and that the bad records made up the balance, and after the peg trays were carried back into Mr. Dodd's room, they were gone over by Mr. Aylsworth and myself. The records in the boxes were then sent to Mr. Payne, each lot being carefully marked and kept separate.

*Q.* 23. Did you ever attempt to make any summary of the results of the molding and inspection so far as Mr. Sturm's department is concerned?

*A.* Yes, I took the tickets which were turned over to Mr. Aylsworth and myself by Mr. Sturms and made a table showing the total number molded of each composition, and the number rejected for the various reasons by Mr. Sturm's inspection, and the number of records which were sent to Payne.

*Q.* 24. I call your attention to the table which appears at the end of answer to question 60 of Mr. Aylsworth's deposition, just given in this case and ask if the figures there contained correspond with those obtained by you as the result of your examination of Mr. Sturm's reports, and of your own observation?

*A.* Yes, this table is correct. The number molded is obtained by subtracting from the total number which were tested by Mr. Sturms, those which were held to be defective for the following reasons: "Rings," "Wax chips," "Bruised," "Dirty mold" and "Scratched." The column headed "Not round" and "Run out" refers to the rejections which were made by Mr. Payne's tests with the exception of two "Not round" records of Composition C, which were rejected by Mr. Sturm and which are added into the "Not round" figures of Mr. Payne.

*Q.* 25. Did you also examine Mr. Payne's reports?

*A.* Yes, sir, I went over them with Mr. Aylsworth when he made up this table.

*Q.* 26. Did these reports correspond with the figures shown in the column "Not round and run out" except in the case of the two records which were rejected for the first of these reasons, by Mr. Sturm?

*A.* Yes, it is entirely accurate as shown by the table which I made up at the same time.

*Q.* 27. Why was it in the compiling of this table by Mr. Aylsworth you did not include all of the records that were rejected by Mr. Sturm?

*A.* Mr. Aylsworth said that the rejection on account of "Rings," "Wax chips," "Bruised," "Dirty mold" and "Scratched" had nothing whatever to do with the qualities of the different compositions and that therefore it would be improper to put them in the table which was made up and they were therefore stricken out and were not taken into consideration in connection with the records of either of the compositions.

*Q.* 28. Have you a statement of all the records that were rejected for these reasons, which you state are independent of the composition itself, in case counsel for defendant wishes to examine the same? *A.* Yes, I have.

*Q.* 29. In connection with these experiments that you assisted in making, did you ever make any experiments to determine the relative fluidity of the several compositions?

*A.* Mr. Aylsworth and I put in two days making fluidity tests upon each of the compositions. This work was done on January 9th and January 10th, 1907.

*Q.* 30. How were those tests made?

*A.* Those tests were made by taking about eight pounds of each composition and melting it in a pot or kettle over a gas burner; the test was made by taking a small funnel which had a small opening at the bottom and notches cut in the upper edge of the rim; this funnel would be held by Mr. Aylsworth in a pair of pliers and immersed in the wax until it reached the same temperature as the wax. He would then remove it from the wax and very quickly allow the melted wax to run out so as to have a hot empty funnel. He would then float it on the surface of the wax, calling out to me at the instant the floating began and I would note down the time from my watch. The wax began to flow into the funnel from the opening in the bottom and as soon as the funnel was filled it would sink and the instant of sinking was called out by Mr. Aylsworth and noted by me. A series of readings were taken so as to average the results and each composition was tested at a temperature of approximately 342 deg. F. and 320 deg. F.

*Q.* 31. How many readings were made with each composition at each of these temperatures?

*A.* Six readings at each temperature.

*Q.* 32. Now take the several compositions and state what the results of your figures, at the several temperatures, show?

*A.* Composition B at the low temperature filled the funnel and caused it to sink in an average of one minute, 19⅓ seconds, and at the temperature, 1 minute, 3½ seconds.

Composition C caused the funnel to sink at the low temperature in 1 minute, 8¾ seconds, and at the high temperature in 56 seconds.

Composition D caused the sinking of the funnel at the low temperature in 1 minute, 33½ seconds, and at the high temperature in 1 minute, 10½ seconds.

Composition E caused the sinking of the funnel at the low temperature in 1 minute, 15 seconds, and at the high temperature in 1 minute, 4⅙ seconds.

In making these tests every effort was made that the conditions should be as uniform as possible and that the times of floating and sinking should be as accurate as possible.

No cross-examination.

Signature and certificate waived.

WILLIAM F. NEHR, a witness produced on the part of the complainant being duly sworn according to law testified as follows.

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. Give your name, age residence and occupation.

*A.* My name is William F. Nehr, I am 29 years of age and reside at 212 Valley Road, West Orange, occupation, Foreman of record molding department, National Phonograph Company.

*Q.* 2. How long have you been occupied as foreman of the Record Molding Department of the National Phonograph Company. *A.* About four years in full charge.

*Q.* 3. Do you recall molding any records from special compositions furnished you by Mr. Aylsworth in the latter part of December, 1906 or early in January of this year?

*A.* I do, yes sir.

*Q.* 4. From how many compositions did you mold records?

*A.* Four different ones.

*Q.* 5. Did you know what those compositions were?

*A.* I did not, no sir.

*Q.* 6. Do you know what they were now? *A.* No sir, I do not.

*Q.* 7. By whom was the actual molding done?

*A.* By men employed for that purpose under my special supervision, men employed in the special making of masters.

*Q.* 8. Were those men specially skillful in this art?

*A.* They were so, yes sir, more so than the ordinary.

*Q.* 9. Did you make the effort to have the work done under the same conditions with all the compositions or not?

*A.* I did, yes sir.

*Q.* 10. Did you superintend the molding of records from those 4 Compositions? *A.* I did, yes sir.

*Q.* 11. Who was present during the molding?

*A.* Mr. Aylsworth, Mr. Holden and the men and myself.

*Q.* 12. How far did your work go in making these records?

*A.* After we received the different Compositions for molding we reamed the inside of the records and extracted the records from the molds.

*Q.* 13. By whom was the finishing of the records performed?

*A.* Mr. Sturm's department.

It is stipulated by and between counsel for the respective parties that the four compositions above referred to by the witness Nehr as having been molded by him are the four compositions known respectively as Compositions, B, C. D and E referred to by the witnesses Aylsworth and Holden herein.

Deposition objected to as irrelevant and immaterial.

No cross examination.

Signature and certificate waived.

It is stipulated between counsel for the respective parties that if David A. Dodd were regularly called and sworn as a witness on behalf of the complainant herein, he would testify that he is in charge of the Manufacturing of Wax Compositions for the National Phonograph Company and has been so employed for about 10 years past; that on December 27th, 1906, at the request of J. W. Aylsworth, he made up two batches of wax composition known in the art as "Hard Regular," each of the following formulas:

| | |
|---|---|
| Stearic Acid, .......................... | 800 lbs |
| Sal-soda, ............................ | 172 " |
| Caustic Soda, .......................... | 3616 grams |
| Metal Aluminum, ...................... | 1400 grams |
| Water, ............................ | 30 gals |

That the composition was manufactured as described by the witness Delos Holden in his deposition herein.

That on December 28, 1906, a composition known as "Composition B" was made by taking 450 pounds of Composition A and adding thereto 94 pounds of ceresin, as stated by the witness Delos Holden, in his deposition.

That on December 31, 1906, a third Composition, known as "Composition C" was made by taking 433.1 pounds of Composition B and adding thereto 72.5 pounds of carnauba wax, as stated by the witness Holden in his deposition. That in adding the carnauba wax to said Composition B at the low temperature mentioned by the witness Holden there was little or no foaming developed.

That on January 2d, 1907, a fourth formula known as Composition D was made by taking 412.5 pounds of Composition A and adding theretto 57.6 pounds of carnauba wax, 70.5 pounds of ceresin and 5 pounds of lamp black as described by the witness Holden in his deposition herein. That at the high temperature used in making Composition D, great foaming was developed, which continued for several hours, until the mass became quiescent.

That on January 3d, 1907, a fifth formula known as Composition E was made by taking 462 pounds of Composition C and adding thereto 4 pounds of lamp black as stated by the witness Holden in his deposition and that during the heating of this composition at the high temperature very decided foaming was manifested, as with composition D; and that the several Compositions, B, C, D and E, respectively, were delivered by him to Mr. Nehr's Department and used for the production of molded records therefrom as testified by the witness Nehr herein.

AUGUST STURM, a witness produced on the part of the Complainant having been first duly sworn according to law testified as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. State your name, age, residence and occupation.

*A.* August Sturm, age 36, residence 20 Summit street, Orange; occupation at present, foreman of the Inspection Department of the National Phonograph Company.

*Q.* 2. How long have you been in charge of this work?

*A.* Almost three years.

*Q.* 3. Did you have occasion in December or January last to inspect any special records for Mr. Aylsworth? *A.* Yes, sir.

*Q.* 4. Did you make inspection of these records personally or did you personally supervise the inspection of them?

*A.* I personally supervised the inspection.

*Q.* 5. Can you produce the inspector's records showing the reresult of the inspection of these records?

*A.* I hand you the reports.

*Q.* 6. I show you a table which appears at the end of the answer to question 60 in Mr. Aylesworth's deposition and ask you to compare these reports with the figures that appear in that table and state if the two correspond, omitting from consideration all rejections of records because of "Rings," "Wax chips," "Bruised" "Dirty mold" or "Scratched" or "Not round and run out."

It is stipulated that if this witness should compare these tables and the sum of the tables, his answer would corroborate Mr. Holden's testimony in this respect and corroborate the results set forth in the table following the answer to question 60 in Mr. Aylsworth's deposition?

*Q.* 7. Were the records which you examined for Mr. Aylsworth inspected under your immediate supervision? *A.* Yes, sir.

*Q.* 8. Did you examine the records that were discarded by the inspectors? *A.* Yes, sir.

*Q.* 9. How many inspectors were employed on this work?

*A.* All was done by a single inspector except one batch of 24 records in the case of Composition B.

*Q.* 10. At the time these records were inspected did you know what compositions they were made of?

*A.* No, sir, I did not.

*Q.* 11. Did you know for what purpose the inspection was made? *A.* No, sir, I did not.

*Q.* 12. What if any instructions did Mr. Aylsworth give you concerning the inspection of these records?

*A.* He told me to be sure and not to have them mixed, to keep these different lots separate.

*Q.* 13. In your department do you ordinarily inspect records to detect the faults of "Not round and run out?"

*A.* Yes, sir, for commercial use.

*Q.* 14. In inspecting these special records, did you make an inspection on this point? *A.* No, sir, I did not.

*Q.* 15. Otherwise was the inspection such as you ordinarily give commercial records? *A.* Yes, sir, the same thing.

*Q.* 16. In inspecting these records did you attempt to make the inspection uniform for all the several compositions?

*A.* Yes, sir, one the same as the other.

*Q.* 17. You made no attempt to favor any particular composition? *A.* No, sir.

It is stipulated that the inspections referred to by the witness Sturm were inspections of records made of the four compositions testified to by the witness Aylsworth and that the four batches of reports, identified respectively by the letters B. C. D. and E. refer respectively to the four compositions so identified by Mr. Aylsworth and correctly tabulated by him, subject to correction.

The four batches of reports produced and identified by the witness are offered to counsel for defendant for the purpose of cross-examination.

CROSS-EXAMINATION, by Mr. Massie:

*xQ.* 18. One girl I understand inspected twenty-four records of composition B? *A.* Yes, sir.

*xQ.* 19. Did she inspect for each of the matters printed over the blank forms in these reports except the one headed "Not round and off gauge."

*A.* She inspected for all the other defects.

*xQ.* 20. Is what is here headed "Off Gauge" the same as is sometimes spoken of "Run Out." *A.* Yes.

*xQ.* 21. Did she herself put the pencil figures down on here on the slip bearing her number?

*A.* Yes, sir, they are her figures.

*xQ.* 22. Another girl inspected all the rest of the records that were made at that time? *A.* Yes, sir.

*xQ.* 23. Then other girls inspected for each one of the defects listed in these slips excepting the two "Not Round" and "Off Gauge." *A.* Yes, sir.

*xQ.* 24. And she herself placed the pencil marks on the slips? *A.* Yes, sir.

*xQ.* 25. What did you have to do with it?

*A.* I simply watched the girl and saw that she was doing her work right, that she did not mix up the different lots, and also examined the discards and also saw that she did not mix them with the regular stock.

*xQ.* 26. No inspection was made in your department or under your supervision of the "Not Round" or "Off Gauge."

*A.* No, sir, except two records of Composition C which were rejected by the inspectors because they were not round.

*xQ.* 27. How did the young lady make the inspection of those two which were rejected as being "Not round"?

*A.* I do not remember that.

*xQ.* 28. Can you tell us how she made the inspection for each of the other defects?

*A.* She took a piece of cotton and simply turned them over and looked over them; eye inspection.

*xQ.* 29. Eye inspection? *A.* Yes, sir.

*xQ.* 30. Was there any other inspection made except eye inspection? *A.* Not under my supervision.

RE-DIRECT EXAMINATION, by Mr. Dyer:

*R-dQ.* 31. How experienced were the girls who made the inspections of these records under your direction?

*A.* They were the most experienced girls we have.

*R-dQ*. 32. So far as these defects are concerned which are observed in your department are they readily observable by an eye inspection, that is to say if the record is broken can you notice that with the eye? *A*. Yes, sir.

*R-dQ*. 33. And as to the other defects are they readily observable? *A*. Yes, sir.

*R-dQ*. 34. It does not require any special machine to tell whether a record is broken or not? *A*. No, sir.

*R-dQ*. 35. Are the girls who make these inspections for you educated to such a point that the inspection of one is about the same as the inspection of another.

Objected to as leading.

*A*. Yes, sir, except new girls.

*R-dQ*. 36. But these two girls were experienced hands?

*A*. Experienced hands.

RE-CROSS EXAMINATION, by Mr. MASSIE:

*R-dQ*. 37. I notice among the headings on these report slips, among others, the following: "Broken by 1st inspector" Broken by second inspector" "Dirty mold." can the girls in your department tell by eye inspection the presence of anything to be rejected under each of these three heads? *A*. Yes, sir.

Signature and certificate waived.

CHARLES H. PAYNE, a witness produced on behalf of the complainant having been first duly sworn testifies as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q*. 1. What is your name, age, residence and occupation.

*A*. My name is Charles H. Payne. Age 39. Residence 8 Sterling Place, Newark, N. J., occupation inspector of master records for the National Phonograph Company.

*Q*. 2. How long have you been engaged at this work?

*A*. Since the 16th of April, 1904.

*Q*. 3. How does the inspection of masters compare with the inspection of ordinary commercial records?

*A*. There is quite a difference, they are more careful with the masters, more careful in their inspection.

*Q*. 4. What tests do you ordinarily give to the masters brought into your department?

*A*. Tests for "Run Out" and "Out of Round" for the surface, and tone.

*Q*. 5. What is "Out of Round" as the expression is used by you? *A*. It is an oval record, oval shape.

*Q.* 6. What is meant by "Run Out"?

*A.* A "Run Out" record is more oval on one end than the other and causes a sort of a zigzag, what we call a drunken thread.

*Q.* 7. Did you have occasion in January last to test four different lots of records for Mr. Aylsworth? *A.* Yes, sir.

*Q.* 8. Do you remember how those records were designated?

*A.* By the letters B. C. D. and E.

*Q.* 9. Did you make a careful inspection of those records, or have such inspection made? *A.* I had the inspection made.

*Q.* 10. Under your immediate direction?

*A.* Under my direction, yes, sir.

*Q.* 11. Who made this inspection? *A.* Miss Mamie Speer.

*Q.* 12. Did you verify the inspection made by Miss Speer of these records? *A.* I did, yes, sir.

*Q.* 13. You saw that it was correct?

*A.* Yes, sir, I watched her do the work.

*Q.* 14. What inspection did she make, to detect what faults?

*A.* For "Run Out" and "Out of Round."

*Q.* 15. Can you produce the reports of Miss Speer giving the results of these inspections? *A.* Yes, sir; here are the reports.

*Q.* 16. Take up the first Composition, B. and state how many records were sent to your department?

*A.* There were 72 records.

*Q.* 17. Please refer to the report of the inspection of these records and state how many were rejected as being "Run Out."

> Objections based on incompetent reports are reserved.

*A.* There were 32.

*Q.* 18. And how many of this lot were rejected as being "Out of Round." *A.* Twenty-four.

*Q.* 19. How many records were accepted as good records?

*A.* Fourteen.

*Q.* 20. There being thirty-two records that were rejected as "Run out" and twenty-four that were rejected as "Out of round" and fourteen that were accepted as good, making seventy and you having received seventy-two, what became of the other two reocrds?

*A.* There were two cracked, they were broken in handling.

*Q.* 21. Please refer to the report of the inspection of lot C and state how many records you received of this lot?

*A.* I received thirty-one records.

*Q.* 22. How many records were rejected as being "Run out?"

*A.* Twenty-one.

*Q.* 23. And how many were rejected as being "Out of round?"

*A.* There were not any.

*Q.* 24. How many were accepted as good? *A.* Ten.

*Q.* 25. Now, please refer to the report of inspection of lot D and state how many records you received of this lot?

*A.* Sixty-five.

*Q.* 26. How many were rejected as "Run out?"

*A.* Thirty-one.

*Q.* 27. And how many as "Out of round?" *A.* Four.

*Q.* 28. How many were accepted as good records? *A.* Thirty.

*Q.* 29. Please refer to the report of the inspection of lot E and state how many you received? *A.* Sixty-eight.

*Q.* 30. How many were rejected as "Run out?"

*A.* Twenty-nine.

*Q.* 31. How many as "Out of round?" *A.* Eleven.

*Q.* 32. How many were accepted as good? *A.* Twenty-eight.

*Q.* 33. I call your attention to these reports and ask in whose hand writing they are?

*A.* The reports are in Miss Speer's hand writing, signed by me.

*Q.* 34. You recognize her handwriting? *A.* Yes, sir.

*Q.* 35. You have seen her write before and know that she wrote those reports? *A.* Oh, yes.

*Q.* 36. The signature "C. H. Payne" appearing on these reports is your own signature? *A.* My signature.

*Q.* 37. And in your own handwriting? *A.* Yes, sir.

*Q.* 38. From whom did you receive your instructions to make an inspection of these four lots of records?

*A.* From Mr. Aylsworth.

*Q.* 39. Did he tell you what these records were? *A.* No, sir.

*Q.* 40. Did he tell you what compositions they were made of?

*A.* No, sir.

*Q.* 41. What instructions did he give you regarding them?

*A.* He told me to give them a test for "Run out" and for "Out of Round."

*Q.* 41. Did he state that the test was to be the same for all or was it to differ with different lots?

*A.* The same for all; he told me to put them through by regular inspection.

*Q.* 43. You knew I presume that the records had something to do with litigation or a suit? *A.* No, sir, I did not.

*Q.* 44. You did not even know that?

*A.* No, sir; it is quite a common thing for me to get special records to be tested.

*Q.* 45. In having these records inspected did you endeavor to treat them all as nearly alike as possible? *A.* Yes, sir.

*Q.* 46. Not favoring one in preference to the other?

*A.* No, sir; I instructed Miss Speer to put them to the regular tests.

*Q.* 47. As a matter of fact do you know which of these lots of records I would prefer to see make a good showing?

*A.* No, sir.

*Q.* 48. Did you make any inspection of these records so far as their surface is concerned? *A.* Yes, sir.

*Q.* 49. Did you observe any differences in the character of the surface of the several lots?

*A.* Yes, sir, I did, in every lot I found a difference.

*Q.* 50. What lot of records has the worst surface?

*A.* The lot B.

*Q.* 51. What was the character of the surface of lot B?

*A.* It seemed to have a kind of ragged edge to it as though it did not mold clean, a very loud surface.

*Q.* 52. Did you examine these records under the microscope?

*A.* Yes, sir.

*Q.* 53. Did you test them on the phonograph? *A.* Yes, sir.

*Q.* 54. Did you find that the surface of lot B was in fact rough when reproduced? *A.* Yes, sir.

*Q.* 55. What about the surface of the other lots, were those surfaces better than lot B?

*A.* They were much better than B, yes, sir.

*Q.* 56. Which has the best surface, do you remember?

*A.* Lot E.

*Q.* 57. Did you ever make a wear test for those records?

*A.* Yes, sir.

*Q.* 58. What does a wear test consist of?

*A.* To see how the record stands under the speaker and how long it will wear, how many reproductions it will stand without wearing out.

*Q.* 59. As I understand, you have an automatic machine which plays the record over and over again, playing one minute for each performance, and automatically repeating? *A.* Yes, sir.

*Q.* 60. So that in one hundred and fifty minutes you know the record has been played one hundred and fifty times? Is that correct? *A.* Yes, sir.

*Q.* 61. And these records were tested on a machine of that kind? *A.* Yes, sir.

*Q.* 62. Were they all tested on the same machine?

*A.* On the same machine and the same speaker, each record.

*Q.* 63. Under the same conditions?

*A.* Under the same conditions.

*Q.* 64. Can you state which batch of records showed up the worst under this wear test?

*A.* Lot B, I could not give it a wear of one hundred and fifty turns; one wore out, I couldn't say positively whether it was after eighty-five times or not, and the others at about one hundred; it got so bad I could not run it any longer.

*Q.* 65. That is to say in Lot B the records wore out in less than one hundred times? *A.* Yes, sir.

*Q.* 66. Do you remember which lot showed up the next best?

*A.* Lot C.

*Q.* 67. How many times were you able to get reproductions from Lot C? *A.* One hundred and fifty times.

*Q.* 68. And were they pretty well worn out after one hundred and fifty times?

*A.* They were worn with the hundred and fifty times pretty well.

*Q.* 69. And what was the next best? *A.* Lot D.

*Q.* 70. How many reproductions were you able to get from Lot D? *A.* One hundred and fifty.

*Q.* 71. Lot D was somewhat better than Lot C? *A.* Yes, sir.

*Q.* 72. As I understand it, lot C had pretty well worn out at one hundred and fifty, and lot D ran a little better than that?

*A.* Yes, sir.

*Q.* 73. What was the best wearing record, what lot?

*A.* Lot E.

*Q.* 74. That was better than lot D? *A.* Yes, sir.

CROSS EXAMINATION, by Mr. Massie:

*xQ.* 75. In answering Mr. Dyer just now giving the figures of how many records you received and how many were "Run Out" and so forth, you were referring to the written list, were you not?

*A.* Yes, sir, I made this list out myself.

*xQ.* 76. Do you recall a day or two ago making a thread test on a special machine in the presence of complainant's counsel, Mr. Dyer, Mr. J. W. Aylesworth and myself? *A.* Yes, sir.

*xQ.* 77. Was that the machine the tests were made on for lots B. C. D. and E? *A.* Yes, sir.

*xQ.* 78. In the wear test did you have the same reproducer all the time, have the same stylus? *A.* Yes, sir.

*xQ*. 79. How many records of each class did you submit to this wear test? *A*. One of each selection.

*xQ*. 80. Which did you test first?

*A*. I tested lot B first.

*xQ*. 81. And then C and then D and then finally E?

*A*. Yes, sir.

*xQ*. 82. How many selections were there?

*A*. There were two in each lot.

*xQ*. 83. So that you tested two records from those marked B, two from C and so forth? *A*. Yes, sir.

*xQ*. 84. In the report of Miss Speer I notice on the first page of lot B one record is noted as "Run out bad," does that mean that that particular record was unfit for use?

*A*. Yes, sir, that was very bad.

*xQ*. 85. Could any of the records examined by Miss Speer on that occasion and which she noted as "Run Out" be employed as a sound record, other than as a master?

*A*. I don't know, none of them would pass my inspection.

*xQ*. 86. On the second page of the same report for lot B I find one having the remark "Blind, cannot measure" and the ditto marks below it indicating that the same remarks apply to the next record; what does that refer to?

*A*. That is where it threw the reproducer off, jumped over into another line; the thread was so warped that it could not measure.

*xQ*. 87. The two records against which this remark was entered could not be reproduced by the phonograph, is that it?

*A*. Well I could not say as to that, I did not try this particular one on the phonograph; if you could they would very soon tear the thread out and put it in bad shape, the record would be no good.

*xQ*. 88. In the same lot B I notice one column of which the following are sample entries: "½ long" and "½ short" and "¼ short" and so forth, what does that refer to?

*A*. That is the thread, the measurement of the thread.

*xQ*. 89. What does it mean? *A*. How is that.

*xQ*. 90. That is what do you mean by saying the thread is one quartaer long for instance?

*A*. Well, that is due to shrinkage.

*xQ*. 91. The threads are supposed to run one hundred to the inch? *A*. Yes, sir.

*xQ*. 92. And in the record reported one quarter short for instance that means there are only 99¾ threads to the inch?

*A.* No, sir, that means the whole length of the record; it is quarter short or long in the whole length of the record, about 425 turns.

*xQ.* 93. About what is the average length of those records?

*A.* About four inches.

*xQ.* 94. When a record is recorded "½ long" that means that instead of having 400 threads on the cylinder, on that four inches long, there are 400½ threads?

*A.* No, there are 399½ threads.

*xQ.* 95. The first item of lot B, selection 9298, serial 23, is reported "½ long" after which follows "O. K.," while the very next item has the ditto marks under "½ long" followed by "Run Out;" can you explain why one was O. K'd and the other rejected?

*A.* There is an uneven shrinkage in one where there is not in the other; one is "run out" and the other is not.

*xQ.* 96. Is this correct, in the record which passes the test in your department and is O. K'd there may be some very small, very slight distortion of the record groove, but it is so small that you nevertheless passed the record, while in the record that you rejected this distortion is marked, and therefore you rejected the record, is that correct? *A.* Yes, sir.

*xQ.* 97. Where do you draw the line, is there any particular standard or line so that if the thread is distorted more than that much you reject the record, and if it is not distorted so much you pass it?

*A.* I have a dial that shows that. You are referring to the thread are you?

*xQ.* 98. Yes. *A.* I have a dial, yes, sir.

*xQ.* 99. I refer to "Run Outs" now.

*A.* Yes, that is correct, if the "Run Out" is too pronounced the record is rejected.

*xQ.* 100. That is if the pointer carried by the reproducing stylus vibrates too far from one side to the other the record is rejected?

*A.* Is this a "Run Out" or "Out of Round?"

*xQ.* 101. This is a "Run Out."

*A.* That shows it on that dial, too far out.

*xQ.* 102. My question is how far out is that dial permitted to travel and yet the record would not be rejected, what is the standard or gauge?

*A.* About three-quarters of a thread, anything up to three-quarters of a thread is not objectionable.

*xQ.* 103. Now about "Out of Round;" is it not a fact that a record cylinder might not be an absolutely exact mathematical circle and yet not sufficiently "Out of Round" to be rejected.

*A.* Yes, sir, the record might be very slightly "Out of Round" and still be good enough for acceptance.

*xQ.* 104. The fact of being "Out of Round" is looked for on that same instrument that you used for Mr. Aylsworth in my presence the other day? *A.* Yes, sir.

*xQ.* 105. And the vertical vibrations of the pointer carried by the reproducer are observed to determine the condition of being "Out of Round." *A.* Yes, sir.

*xQ.* 106. How much play or how much vibration of this pointer could there be and yet a record would not be rejected, what is your limit in that regard?

*A.* I could not give you the exact amount, that is a question of practice.

*xQ.* 107. Can a record which your department rejects because it is "Out of Round" be put on a phonograph and reproduced so that it will reproduce fully from one end of the record to the other, when it is "Out of Round."

*A.* Yes, sir, it can, but it will give a very poor reproduction, and the needle will bear on one side and it will sound as though it was one sided.

*xQ.* 108. That is, when the thicker part of the cylinder is under the needle the pressure would be heavier and the sound would be somewhat louder and vice versa when the thinner part of the cylinder is under the needle the sound would not be so loud so that the expression would not be of uniform volume.

*A.* No, sir, the sound would waver.

*xQ.* 109. What did you personally have to do with these tests that Miss Speer made and of which she made the reports which you have now handed us?

*A.* I oversaw them and watched them, she did it in my room.

*xQ.* 110. What I mean to get at is this, if you were standing there and watching her do it you could have done it yourself could you not, that is, what did she do that you could not do?

*A.* She put the cylinder on and measured them, took them off and marked them on her report each one in my presence.

*xQ.* 111. That is practically she did the manual part and you were really making the inspection yourself in the sense that you watch her and saw that she did it correctly?

*A.* I did not watch every one that she put on.

RE-DIRECT EXAMINATION, by Mr. DYER:

*R-dQ.* 112. What about Miss Speer's ability, do you regard her as an experienced girl at this sort of work?

*A.* Yes, she is very good, she worked for me for a year.

*R-dQ.* 113. In making these inspections she had no knowledge as far as you know of what particular compositions she was working on? *A.* Oh, no.

*R-dQ.* 114. She gave them the usual master inspection?

*A.* Yes, sir.

*R-dQ.* 115. And as far as you could tell the inspection was the same for one lot as for the others?

*A.* Yes, sir, she aways put them right through on the regular test for masters as she has always done.

Signature and certificate waived.

MAMIE SPEER, a witness produced on the part of the complainant, having been first duly sworn testifies as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. By whom are you employed? *A.* Mr. Nehr.

*Q.* 2. Mr. Nehr is the foreman of the molding department of the National Phonograph Company, is he not? *A.* Yes, sir.

*Q.* 3. Where do you live?

*A.* Ridgehurst Road, West Orange.

*Q.* 4. At what work were you employed before you went with Mr. Nehr?

*A.* I worked at testing and measuring the masters.

*Q.* 5. In whose department? *A.* Mr. Payne's.

*Q.* 6. How long were you employed in Mr. Payne's department?

*A.* I worked there just about a year to the day.

*Q.* 7. Did you test many masters while you were employed by Mr. Payne?

*A.* Yes, sir, not less than one hundred a day.

*Q.* 8. What kind of tests did you apply to masters when you were with Mr. Payne, what did you do in testing those masters?

*A.* Measured them for "Out of Round" and "Run Outs" short and long.

*Q.* 9. What do you mean by "Out of Round?"

*A.* Well "Out of Round" is when the needle or dial on the machine kind of wobbles up and down.

*Q.* 10. What do you mean by "Run Out."

*A.* When they go side ways.

*Q.* 11. What do you mean by short or long?

*A.* When it runs short, the dial shows this side of the center.

*Q.* 12. On the left of the center?

*A.* On the left of the center and when it is long it goes just the opposite way, to the right of the center.

*Q.* 13. Do you remember making some tests for Mr. Payne in January last of some special records?

*A.* Yes, sir, there were several lots?

*Q.* 14. How many lots?

*A.* Several I don't know just how many.

*Q.* 15. You went up from Mr. Nehr's room to Mr. Payne's room for the purpose of making that inspection?

*A.* Yes, sir.

*Q.* 16. Why did he call you up do you know?

*A.* I understood from him the other girl was too busy so he sent for me.

*Q.* 17. I show you four reports which appear to relate to lots B, C, D, and E respectively, and ask you whether you recognize those reports? *A.* Yes, sir, they are mine.

*Q.* 18. Are those reports in your handwriting?

*A.* Yes, sir, they are.

*Q.* 19. Do those reports show the result of your inspection of those records? *A.* Just as I measured them.

*Q.* 20. It would appear from these reports that you measured four lots of records? *A.* Yes, sir.

The reports identified by the witness are offered in evidence and marked:

"Complainant's Exhibit, Inspectors Report, Lot B."
"Complainant's Exhibit, Inspectors Report, Lot C."
"Complainant's Exhibit, Inspectors Report, Lot D."
"Complainant's Exhibit, Inspectors Report, Lot E."

*Q.* 21. In making your inspection of these four lots of records did you endeavor to give the same inspection to all of them?

*A.* Every one of them, I tested them just as I would a master.

*Q.* 22. You did not try to favor one lot over another?

*A.* No, sir, I did not know one lot from another except by a little slip inside to which I paid no attention.

*Q.* 23. Do you know now what those records were that you inspected?

*A.* Well I don't know exactly what they are, I don't know what they are yet, I don't know anything about them.

CROSS-EXAMINATION, by Mr. MASSIE:

*xQ.* 24. Besides observing the movements of the pointer up and down and from side to side did you pay any attention to the selections themselves, did you listen to them.

*A*. No, we would test them for nothing else.

Signature and certificate waived.

Adjourned until Monday, March 4th, 1907, at 10 o'clock A. M., at the office of Mr. Dyer, Edison Laboratory, Orange, N. J.

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ORANGE, N. J., March 5, 1907.

Met pursuant to agreement.

Present—Counsel as before.

DAVID A. DODD, a witness called on behalf of complainant, having been first duly sworn, deposes and says as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q*. 1. Give your name, age, residence and occupation?

*A*. David A. Dodd, age 45, residence 273 Dodd street, E. Orange; foreman of the Wax Department of the Edison Phonograph Works.

*Q*. 2. What are your duties?

*A*. The manufacture of wax for the molded records; also blank composition for making the blanks.

*Q*. 3. Are these compositions made by the Edison Phonograph Works?

*A*. They are, and delivered to the National Phonograph Company.

*Q*. 4. Which concern makes the molded records?

*A*. The National Phonograph Company. The Edison Phonograph Works still makes the blanks.

*Q*. 5. How long have you been in charge of the Wax Department of the Edison Phonograph Works?

*A*. Since May 1897.

*Q*. 6. Are you able to state when the National Phonograph Company first put its molded records on the market?

*A*. In February 1902.

*Q*. 7. Did you have anything to do with the manufacture of molded records at that time? *A*. I did.

*Q*. 8. In what way were you connected with the matter?

*A*. I was in charge of manufacturing the records from the time they were first put on the market, and I remained in charge until May 1904.

*Q*. 9. During this time then you were, as I understand it, making the composition and also molding records? *A*. Yes, sir.

*Q*. 10. From the time the National Phonograph Company first put out its molded records in February 1902, were many molded records made?

*A.* Yes, for the first year we made at least an average of 10,000 a day.

*Q.* 11. Are you familiar with the patent in suit herein, No. 782,375 of February 14th, 1905? *A.* I am.

*Q.* 12. From the time the National Phonograph Company first put out its molded record in February 1902, up to November 3, 1903, when the application for the patent in suit was filed, what was the composition used in the manufacture of such molded records?

*A.* The same as in the patent, made after exactly the same formula using carnauba wax, and made exactly as described in the patent.

*Q.* 13. And between the dates mentioned you personally superintended the manufacture by the National Phonograph Company of more than 10,000 records a day made of the exact composition of this patent? *A.* I did.

*Q.* 14. Who succeeded you in charge of making the records?

*A.* Mr. Nehr and Mr. Bork.

*Q.* 15. Do you recall having anything to do in January last, with records made of special compositions for Mr. Aylsworth?

*A.* I did; I personally made up different batches as Mr. Aylsworth directed.

*Q.* 16. Did you see the records made from these compositions?

*A.* Yes, they were delivered to me after they were molded by Mr. Nehr. I delivered them to Mr. Sturms for his inspection, and Mr. Sturms returned them to me with the discards.

*Q.* 17. Do you recall how these records were indicated or marked? *A.* They were lettered B, C, D and E.

*Q.* 18. And what, if anything did you do with the good records received from Mr. Sturms?

*A.* I delivered them to Mr. Payne for his inspection.

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ORANGE, N. J., March 8, 1907.

Met pursuant to agreement.

Present—Counsel as before. Also MELLVILLE CHURCH, ESQ., Counsel for Complainant.

ARTHUR S. BROWN, a witness called on behalf of the complainant having been first duly sworn, testified as follows:

DIRECT EXAMINATION, by Mr. DYER:

*Q.* 1. You have already testified in this case I believe? *A.* Yes.

*Q.* 2. Have you read the testimony taken on behalf of the defendants herein? *A.* Yes.

*Q.* 3. Have you also read the deposition of Mr. Edison and so much of the deposition of Mr. Aylsworth as includes his answer to question 247? *A.* Yes.

*Q.* 4. Compare the invention of the patent in suit with the prior art as the same is disclosed by the prior patents referred to by defendant's witnesses and state whether or not you find the subject matter of the patent in suit to have been new at the date of the application therefor?

*A.* The sound record composition specifically set forth in the Aylsworth patent in suit is composed of metallic soap containing free stearic acid and made in the manner specifically set forth, together with carnauba wax and ceresin or other hydro-carbons, incorporated with the metallic soap, as particularly set forth, to which is added a coloring material such as lamp black, when desired. The whole forms a homogenious mass which is used for making molded phonograph sound records. As the defendant's molded records are composed of the same ingredients made in substantially the same way I will discuss the novelty of this particular composition in the light of the prior art as disclosed by the patents referred to by defendant's witnesses. It is unnecessary in this discussion to consider the question of possible equivalents which may be used for any of the various ingredients, since the specific composition of the Aylsworth patent is that which is used by the defendant, although the Aylsworth patent suggests variations at lines 9 to 18 of page 2 where it is said:

e/

> "In describing my improved composition and the process which I prefer to follow in compounding the same I shall refer to preferable proportions of ingredients, to preferable steps or procedures in the process, and to preferable temperatures, all based on actual practical experience in this art; but it will be understood that in these respects considerable variations may be made, as will be obvious to those skilled in the art."

The composition of the Aylsworth patent is specifically designed and intended for making molded phonographic sound records, that is to say, records which can be immediately used on suitable sound reproducing machines for reproducing sounds. These sound records are made by the aid of a metallic mold consisting of a hollow cylinder with suitable variations on its interior surface conforming to sound waves into which the molten liquid composition is cast. While the sound record material is still hot within the hollow cylindrical mold and while yet in a semi-plastic condition, although still tightly engaging the interior variable record surface of the mold, the interior of the molded material is reamed so as to form a series of internal ribs, which will fit the mandril of the sound producing machine. After these ribs have been formed, the further cooling of the molded composition causes it to shrink away from the interior variable record surface of the mold so that the record can be withdrawn longitudinally.

This molded record then carries on its exterior surface a sound record formed therein by the record variations on the interior surface of the mold and that surface of the molded sound record is ready for use on the sound reproducing machine without any further treatment. Assuming the record is made of a composition which shrinks with substantial uniformity and without undue warping, as in the case of the patented composition, the outer surface of such a molded record will be concentric with its interior surface so as to be perfectly fitted for use on a phonograph.

The composition of the Aylsworth patent is not only entirely suitable for thus making molded sound records, but it is durable, being capable of continued use without material deterioration; it can be used at all seasons of the year in all climates without variation in its ingredients or in the method of the manufacture; it reproduces the sound satisfactorly, and when made black, by the use of lamp-black, any imperfections may be readily detected.

The capacity of a material to be thus successfully employed for making molded sound records usable under all practical conditions, is of the highest practical importance. The sound reproducing or phonographic art has so developed that the principle commercial use of phonographs is for purposes of entertainment. A noted artist or a well known band performs in the presence of a sound recording machine which makes a master-record and it is necessary, commercially and practically, that a very large number of duplicates should be quickly and economically made which can be bought by owners of sound reproducing machines. Accordingly an effective plan for making duplicates from the master record is of fundamental importance, and hence, a suitable composition or material for making such duplicates is necessary. Again, each duplicated sound record which gets into the hands of a user must be capable of many repetitions. The value of the sound record to the user depends upon its capacity for repeated use without material deterioration. Also, it is obvious that it cannot be predicted at the time the duplicates are made where or when they are to be used so that they must be capable of use, in all climates and at all seasons, without deterioration.

The composition of the Aylsworth patent in suit satisfactorily meets these requirements and has been extensively used.

In considering the availability of a composition for making a molded sound record the exceedingly rigorous requirements of the phonographic art must be borne in mind. The sound groove which is cut by the sound recording machine in the original blank is of minute depth, at the maximum, less than one one-thousandth of an inch deep and the available width of surface for the sound groove is only one one-hundredth part of an inch. Nevertheless, all of the sound variations which may be due to the playing of an entire band in front of the reproducing machine, with the fundamental and over-tones of each instrument, must produce a varying effect on this sound groove, which, practically, is so perfectly done that the ear of the listener subsequently using the molded sound record can identify the individual musical instruments of the band. The sound groove, which is cut with these variations in shape, must represent not only the complexities of the impressed sound, but also the variations are made with enormous rapidity, the sound vibrations in a single second of time for the higher musical notes running into thousands. Assuming, that the master-record thus produced is perfectly and satisfactorily made, the duplicate record must have all of the perfection of the master record. The duplicate must exactly reproduce all of the minute variations in the sound groove which are in the master-record and without distortion and without deviation.

Not only does the composition of the Aylsworth patent in suit fulfill the mechanical conditions required in making a successful cast from the mold but also the sound records made therefrom, but it fulfills the requirements of durability in all climates and has the acoustic perfection due to exact duplication of the original minute variable sound grooves.

The proposition, therefore, which is presented for discussion is as to whether or not the plastic composition was the result of the well known resources of the art so that any person having knowledge of the art at the date of the Aylsworth invention could have, without experiment and inevitably, made a composition having all the characteristics and capabilities, which I have mentioned; and which are set forth fully and in detail in the Aylsworth patent in suit.

I shall consider the prior state of the art with a view of determining this proposition. Before referring specifically to the various disclosures of the prior art it is important to keep clearly in mind the distinction between a "molded sound record," such as the composition of the Aylsworth patent in suit is designed for, and an "original" sound record, made directly by the action of a recording machine. Such original, or "master" sound records, are produced upon blanks made for that purpose. These "blanks," as they are now commonly and briefly called, (in the earlier art they were sometimes called "Phonograms," or "Phonogram Blanks") are cylinders having a smooth outer surface in which the sound groove is cut by the use of a recording tool or stylus with which the recording instrument is provided and which is vibrated by sound waves. These blanks are made with special reference to their adaptability for being cut by the recording stylus and to that end must have suitable properties, so as to adapt them to having a smooth, clean, record groove cut in them which will conform in shape to the impressed sound waves. The essential qualities of the blank are that it shall be fit for the cutting of the sound groove. On the contrary, in the manufacture of molded sound records, the properties of the composition are determined, not by the exigencies and requirements of the sound recording operations, but by the conditions attending sound reproduction. Evidently, it was first necessary, in the phonographic art, to efficiently record the sound. Until that was done, improvements in the reproduction had to wait. The history of the art, as disclosed by the patents referred to by defendant's witnesses, shows that in the early stages the problem to which inventors directed their energies was chiefly in connection with obtaining a suitable material for sound recording. The sound reproducing or phonographic art owes its origin to Thomas A. Edison, whose original invention is set forth in his patent No. 200,521, dated February 19, 1878. This patent is referred to by Mr. Cameron, defendant's expert. In his original phonograph Mr. Edison used tin foil as the recording material and reproduced directly from it. The recording was done by a stylus which indented the tin foil, not removing any of the material thereof. Few inventions have created the wide spread interest which followed this invention of Mr. Edison. It was a sufficient marvel that sound could be reproduced at all. Experience, however, with the original phonograph, demonstrated that tin foil was an unsuitable recording material, and that indentation was an inadequate method. In spite of the pliability of the tin foil it was distorted by the indenting method, each indentation affecting the preceding indentation, and each successive line of indentations affecting the preceding line. The result was that the sound reproduction effected by the same indented lines was imperfect.

This invention showed that sound could be mechanically recorded and reproduced; but tin foil or similar pliable material was not the proper recording material, and the indenting method, with its incidental distortions, was not the proper recording plan. Accordingly, effort was directed towards the production of a suitable recording material and a proper way of getting the sound record in it.

The next patent referred to by Mr. Cameron is that of Bell and Tainter, No. 341,214, dated May 4, 1886, which marked an important advance in the art. The Bell and Tainter patent describes a sound record blank composed of a foundation of paper or pasteboard with a surface coating made of a compound of beeswax and paraffine, the latter in excess. This composition is referred to, in the Bell and Tainter patent, as being "wax-like," this being the introduction into the phonographic art of this expression. For example claim 12 of this patent reads:

> "12. The sound or speech record cut or engraved in a wax-like composition, such as the compound of beeswax and paraffine, substantially as described."

And the specification, in defining what is meant by "wax-like" or "waxy" says

> "The invention consists, secondly, in engraving or cutting the record in a waxy or amorphous and slightly cohesive substance." (Page 1, lines 59 to 61).

In other words, an amorphous and slightly cohesive substance capable of being smoothly cut, is what is identified as "waxy" or "wax-like."

Also, Bell and Tainter, instead of indenting the sound recording material, introduced the method of cutting, or gouging out the wax-like material, actually removing the substance in chips or shavings, so that the recorded sound wave appears as a depressed groove cut in the surface of the wax-like material.

This is the method which is in commercial use at the present day for phonographs and graphophones in the manufacture of the original or master records from which the present molded sound records are copied, by casting, as explained.

The sound record material used by Bell and Tainter was wax-like in the sense that it was adapted to, the cutting or engraving method, was amorphous and slightly cohesive, and the particular wax-like material disclosed by them was composed of bees-wax and paraffine.

Bell and Tainter used the sound record so produced directly for reproducing purposes.

In considering the further development of the art I will take up the various subsequent patents referred to by Mr. Cameron in the order of their filing dates (which differs from the order of their issue dates), because by so doing, the historical progress will be shown in correct sequence.

The Tainter patent No. 421,450 was granted February 18, 1890, on an application filed November 14, 1887. This patent deals with the problem of making a suitable recording surface, the specifications saying,

> "This invention has reference to the preparation of a recording surface or medium for graphophones or apparatus for recording and reproducing speech or other sound wherein the sound record is cut or graven by a cutting style in a surface such as wax or waxy composition" (page 1, lines 8 to 14)."

This patent recognizes that there are diverse and apparently contradictory properties which a sound recording material must possess. It says

> "There are certain properties or characteristics in the recording medium that are desirable or essential to the successful operation, and which are difficult owing to their somewhat contradictory nature, to find combined in one substance." (Page 1, lines 27 to 32).

The specification then goes on to point out that there must be the right degree of hardness and toughness which will not be inconsistent with smooth, even and ready cutting, that the substance, must not be brittle, at the same time must not be too sticky, that it must be fine in texture and not break off irregularly in being cut, and that it should not be susceptible to changes of temperature. Moreover, at that time, the problem was rendered even more complex because the same material was used both for recording and for reproducing sound, the material should have the contradictory properties of being both of the right degree of hardness and toughness and, for reproducing purposes, at the same time should be easily cut for recording purposes. In this connection the specifications claim that

> "Other waxes—such as bees-wax for example—while cutting smoothly and evenly, are too soft and too susceptible to alterations of conditions under changes of temperature * * * * soft waxes, moreover, do not give in reproducing as loud or distinct articulation as harder waxes" (page 1, lines 45 to 55).

This shows that even then the complexities of the problem of a proper phonographic material were recognized and appreciated.

Tainter's attempted solution of this problem was to provide an external coating made of ozocerite (which is unrefined ceresin) on a paste-board tube, foundation.

The patent describes the heating of ozocerite and then says

> "It is then applied in a thin layer or coating to the foundation of paper or other material, and on cooling is turned down until a perfectly smooth surface is obtained" (page 1, line 100).

From this it is plain that a blank was produced with an ozocerite surface which was brought to true form by turning it down (as a metal worker turns down metal in lathes) so as to obtain a smooth surface in which is to be cut the sound groove.

The specification asserts that the discovery of the eminent suitability of ozocerite for a soft recording surface was the result of a long series of experiments, the language being

> "I have found after a long series of experiments that a certain natural or earth wax known as ozocerite is eminently suitable for the purpose of forming graphophonic recording-surfaces, particularly when treated as hereinafter described." Page 1, lines 60 to 65.)

In other words, although the original Bell and Tainter patent, No. 341,214 had pointed out the importance of a "wax-like" material for sound recording purposes, and ozocerite is specified in this Tainter patent No. 421,450, as a natural or earth wax, it required a long period of experiments to demonstrate the availability of ozocerite for that purpose.

Although this Tainter patent describes only how to make a blank with a pasteboard foundation and an ozocerite recording-surface, it says

> "The ozocerite wax may be employed alone, and it is sufficiently cheap for the purpose. It may, however, be combined with other waxes. It mixes readily with bees-wax, carnauba-wax, and others, and its use in such compositions would be within the scope of the invention." page 2, lines 8 to 13)

This was palpably merely a general statement intended to avoid the restriction of the scope of the patent to the use of ozocerite alone. It is not asserted that any beneficial effect is to be produced by the addition of any other ingredient, nor is there any suggestion of how the addition is to be effected or what proportion the other ingredients are to bear to the ozocerite. The only inference of any reason for the addition of another ingredient is in connection with the intimation that ozocerite is "sufficiently cheap"; the inference being that if it is not thought cheap enough it can be adulterated with cheaper materials. In any event, there is no suggestion of any useful results to be obtained by the adding of any other ingredient. This quoted paragraph contains a bald reference to the employment of carnauba wax without suggesting what utility is to be thereby gained.

Manifestly, this patent is wholly valueless in instructing those skilled in the art that carnauba wax might prove to be a useful ingredient in a composition designed for making a molded sound record, as distinguished from a blank to be used for recording purposes, and no one seeking light in this direction would have derived any available suggestion from this Tainter patent.

This was followed by the invention of the patent No. 393,190, dated November 20, 1888, the application for which was filed November 19, 1887. This patent refers to the then pending application for the Tainter patent just previously considered for a statement of the "Difficulties encountered in the preparation of a recording tablet and the reason why most of the waxes commonly known and mixtures of them are unfit for the purpose" (lines 26 to 30). Tainter was still at work on the problem of giving a suitable blank material in which a recording groove could be cut. He thus describes his new improvement.

> "A number of common waxes—such as bees-wax, for example—have certain properties that are advantageous and useful, but lack hardness and resistance to changes of temperature and other conditions requisite to successful employment. Bees wax, for example, cuts smoothly but is too soft and sticky. It has been found that waxes of this nature can be rendered suitable for the use desired by an admixture of a proper proportion of a substance known as "carnauba-wax." This wax itself is very hard and brittle, and in cutting, chips off in small particles; but it mixes readily with beeswax and waxes of like nature and forms a compound eminently suitable for the recording surface of a graphophonic tablet. Among other substances with which the carnauba-wax may be mixed, and which for this purpose may be regarded as the equivalent of beeswax, are ceresin wax, paraffine, and bay-wax—sometimes called "bayberry" or "myrtle" wax.
>
> In preparing the mixture I take from fifteen to forty

> per cent. of carnauba-wax to from sixty to eighty-five per cent. of the softer wax—such as white beeswax. The maximum proportion of carnauba wax is used in warm weather, and at high summer heat will render the mixture sufficiently hard. At more moderate temperatures a smaller amount of carnauba wax is preferably employed.
>
> The waxes, in the proportions indicated, are melted and thoroughly mixed together, and are applied to the base or foundation of the tablet in any suitable way." (Lines 37 to 71.)

The reason thus stated for mixing carnauba wax with bees-wax is because bees-wax is too soft and sticky and alters with changes of temperature. Carnauba wax is employed to avoid stickiness, to make the composition harder, and, by varying its proportion relative with bees-wax, to resist changes in temperature. When used in hot weather forty per cent of carnauba wax is used, whereas for cold weather fifteen per cent suffices. This composition was for making a blank for recording purposes and such use was ephemeral, the pasteboard coated blanks of that kind being available only for a single recording it might then have been feasible to change the mixture to correspond with the season of the year. Manifestly, no such alteration of the proportions of the ingredients would be feasible in connection with molded sound records. The practicability depends upon the capacity for being used a large number of times, whenever the owner wants. The manufacturer of molded sound records cannot vary his composition to suit the seasons of the year.

The sole teaching of this Tainter patent is that by varying the proportion of carnauba wax from fifteen to forty per cent and mixing the same with bees-wax or similar wax, a sound recording blank could be produced suitable for different seasons, which could be readily cut without being too sticky and too soft.

Does this patent contain any information which would have led one familiar with the art, inevitably and without experiment, to the employment of carnauba wax in a composition not already containing beeswax or any of the other waxes specified by Tainter, such as ceresin-wax, paraffine and bay wax, to prepare a composition for making a molded sound record, and not a sound recording blank?

In the first place, Tainter and Aylsworth were seeking a different object. Tainter was trying to overcome defects in sound recording blanks; Aylsworth wanted to get a composition suitable for molded sound records. Tainter's sound recording tablet proved to have been a mere passing expedient in the history of the art, being long since obsolete, and superceded by far more efficacious compositions. The Aylsworth composition proved to have been just what the art was waiting for and it made molded sound records commercially successful. Whatever else may be thought of the information derivable from this Tainter patent leading to the development of the molded sound record, it is certain that it had no immediate fruits in that direction, since fifteen years elapsed between November 19, 1887, when Tainter filed his application, and 1902, when the molded sound records of the Aylsworth patent in suit were placed upon the market; and this in spite of the continuous intervening activity in the phonographic art.

Tainter discovered that the addition of carnauba wax to beeswax in varied proportions according to the season of the year made a suitable sound recording material which was not too sticky and not too soft. Aylsworth had no such object in view. The composition of the Aylsworth patent with carnauba-wax left out is an eminently suitable sound recording material possessing none of the defects which Tainter was seeking to overcome. The Aylsworth composition with the carnauba wax left out is not sticky, so that it cuts smoothly when used as a sound recording blank, it does not alter and change with the climate in its sound recording capabilities, and it is sufficiently hard for such purpose. No addition is required to this composition for any of the purposes which Tainter had in view in using carnauba wax. On the contrary, Tainter was seeking to get a good sound recording blank and he used carnauba wax with that end in view; whereas the composition of the Aylsworth patent with the carnauba wax left out, makes an ideal sound recording blank, and the addition of the carnauba wax makes the composition less useful for sound recording purposes, and the composition is not practically used for sound recording. Tainter mixes carnauba-wax with one material for the purpose of getting a better sound recording cylinder; whereas, Aylsworth, in mixing carnauba wax with wholly different materials, diminishes their availability for sound recording purposes. The objects of the two inventors are exactly opposite.

Moreover, in the Tainter composition the carnauba-wax requires a variation to make the substance available for recording purposes at different seasons of the year; whereas the Aylsworth composition remains constant in its sound producing properties in all climates and at all seasons.

The possibility of casting a sound record in a mold was unknown at the time of the application for this Tainter patent and Tainter had no such possibility in mind. The patent deals solely with trying to get a good sound recording tablet or blank, and proved to be only a temporary expedient which quickly became obsolete and left no permanent or lasting impression upon the practical commercial art. It contains no teaching whatever as to how to make a molded sound record and contains no suggestion which would have led an experimenter to use carnauba wax in case such experimenter was trying to get a composition which should meet all the exacting requirements in casting a molding composition in a mold for the purpose of making sound records.

The next invention to which Mr. Cameron refers is that of the Edison patent, No. 484,582, granted October 18, 1892, upon an original application filed January 5, 1888, only a few weeks after the application of the Tainter patent just considered. This patent is of special interest because it is the first attempt shown by the patents referred to by defendant's witnesses, to make a molded sound record. The patent describes making a metallic mold from an original or master-record which, after having its interior metallic surface shaped in accordance with the variable sound record is split into longitudinal sections. In this connection the specification says:

> "This metal cylinder is then split longitudinally by a very thin saw into a number of parts—say, for illustration, three parts—which are suitably mounted upon levers, so that a mold is formed which can be closed to receive the material to be molded and opened to permit of its being taken out." (page 1, lines 69 to 75.)

Concerning the material to be used for the sound record made by this sectional mold, the specification says:

> "The duplicate phonograms are produced by means of this mold by pouring therein and preferably around a suitable core placed in the mold suitable substances, such as wax or wax-like material, resin, or plaster-of-Paris, the material being preferably too hard to be satisfactorily indented by the phonograph or the duplicate phonograms may be made by taking sheets of smooth material, like waxed paper or tin foil, and pressing them upon the surface of the mold, by a plunger or otherwise, the sheets being afterwards backed up by a wax, resin, or cement" (page 1, lines 75 to 88).

At the time this Edison application was filed on January 5, 1888, the applications for the Tainter patents, No. 393,190 and No. 421,450 (just previously considered) were still pending in the patent office, having both been filed in November, 1887, and presumably their contents were not known by Mr. Edison. At that time the only disclosure of the prior art contained in any patents accessible to Mr. Edison and referred to by defendant's witnesses concerning a "wax-like material," was the disclosure of the original Bell and Tainter patent, No. 341,214 (ubi supra) which specifies a mixture of beeswax and paraffine; accordingly this reference to a "wax-like material," on January 5, 1888, would inevitably have suggested to one then skilled in the art, a mixture of beeswax and paraffine. This Edison patent refers indiscriminately, without indicating any choice, to such a wax-like material, resin, plaster-of-Paris, waxed paper, and tin foil. It also suggests that the material should be "preferably too hard to be satisfactorily indented by the phonograph" but contains no suggestion as to how the Bell and Tainter mixture of beeswax and paraffine is to be rendered harder, and there was then no available disclosure in the art of how such composition might be made harder. At any rate these materials were being introduced into a mold which was longitudinally sawed into sections after the variable sound record had been formed therein. Obviously, this patent not only contained no possible suggestion of the Aylsworth composition, but it discloses an impracticable product. The patent states, as a necessary feature, the sawing of the metallic mold into sections, and any such procedure would inevitably interfere with the variable sound record impressed on the interior of the mold. Variations in sound records of less than one one-thousandth of an inch are important, and no matter how fine the saw might be with which the mold was split, an objectionable interference with the produced sound must have resulted. Evidently Mr. Edison then knew of no way in which a molded record could be withdrawn from an integral mold and he had no composition capable of such withdrawal. The production of a satisfactory molded sound record requires that the sound record composition after being molded should shrink radially inward so that its grooves may become free from the irregularities of the interior surface of the metallic mold, thereby enabling the molded sound record to be longitudinally withdrawn without any disturbance of the finished sound groove.

This Edison patent is absolutely barren of any instruction as to what sort of material would be capable of such action. Instead of this patent affording any direction as to how molded sound records can be successfully made, it simply points out a procedure to be avoided.

As far as this patent goes, plaster-of-Paris, or waxed paper, or tin foil, or resin, is just as available and useful as a "wax-like material." This patent does not even suggest a point of departure for experimentation to follow, much less a disclosure of the complete composition of the Aylsworth patent in suit.

Edison Patent, No. 400,648, dated April 2, 1889, and Edison Patent, No. 430,274, dated June 17, 1890, were both filed on July 30, 1898, but as the latter patent appears on its face to have been signed earlier, I will consider it first.

This Edison patent, No. 430,274, does not relate to sound records but returns to the subject of producing a substance suitable for sound recording purposes, the specifications saying:

> "My invention relates to phonogram-blanks for receiving a record of sound-vibrations and reproducing the same; and my object is to produce blanks having superior qualities for recording and reproducing such vibrations" (lines 8 to 13).

This patent is the original patent for blanks made of metallic soap. The first claim reads:

> "1. Phonogram-blanks made of metallic soap, substantially as set forth."

The specification of the particular metallic soap set forth is so short that I will quote it in full

> "Insoluble soap may be formed of any metal or sometimes of an earthy oxide, like lime, in combination with any fatty acid. For my purpose, however, it is best to use lead, magnesium, or aluminum, combined with oleic or stearic acid, forming an oleate or stearate of the metal used. These compounds are preferred because of their superior amorphous quality. Of the metals named I especially prefer to employ lead, and especially to use a mixture of equal quantities of oleate and stearate of lead, the same being melted and poured into molds, to form the cylindrical blanks.
>
> "The soap may be made according to the usual well-known methods" (lines 20 to 35).

This patent is of interest simply because it shows the conception of the metallic soap composition which has since been used commercially in the manufacture of sound recording blanks; the art still demanding a suitable material in which the sound groove could be cut by the sound recording machine. The metallic soap composition is asserted to have the "amorphous quality" which characterized the wax-like composition of the original Bell and Tainter patent, No. 341,214. The patent makes no intimation that the described metallic soap is useful for any other purpose, or has any properties which would be available in making a molded sound record.

It is silent on that subject and contains no information which would aid anyone seeking to successfully make a molded sound record.

This patent states that the molded composition is "poured into molds to form the cylindrical blank," but this has no reference to the possibility of molding a sound record as distinguished from a blank. On the contrary, it refers to the use of molds simply to give a generally symmetrical shape to the blanks. After the blank is so formed it is subsequently turned down to the proper diameter and given the desired smooth surface preparatory to having a sound groove cut therein. It is of no moment in making such blank that there should be any inward shrinking of the molded material so as to be withdrawn longitudinally without any disturbance whatever of its outward surface (as is essential in molded sound records) since the final smooth surface of the blank is obtained by subsequent turning down.

Edison patent No. 400,648 dated April 2, 1889, and filed July 30, 1888, is for another composition suitable for making blanks to be used in making a record of sound vibrations. The specification says

> "The object of my invention is to produce phonogram blanks or bodies on which are to be produced a record of sound vibrations, and which are to reproduce the same by the aid of the phonograph, which phonogram blank shall be composed of a material having superior qualities for receiving such records and reproducing sound therefrom" (lines 8 to 15).

The specification states that various waxes are desirably used in making compositions for such purpose, but that used by themselves they are too soft. Accordingly the patent says

> "I therefore mix with the wax a harder material which will produce a harder compound.
>
> "I have found that stearic acid is an exceedingly desirable hardening material for this purpose" (lines 20 to 25).

The specific compound set forth is thus described:

> "I have found the best mixture to be as follows: About one hundred parts, by weight, of ceresin, about twenty-five parts of bees-wax and about twenty-five parts of stearic acid" (lines 32 to 35).

The object of this invention is to make sufficiently hard the sound recording blank, stearic acid being used; this is not the object of the Aylsworth patent. If the carnauba wax is omitted from the Aylsworth composition, there is left a composition having every property desirable for a sound recording blank. In fact, the Aylsworth composition without the carnauba wax is made with the employment of stearic acid called for by this Edison patent, so that it is hard enough for sound recording purposes. The problem which confronted Aylsworth was not how to make an efficient sound recording blank, and, in fact, his composition is less useful for that purpose than what was in use prior to his invention. What Aylsworth was after was a composition suitable for making molded sound records, as distinguished from blanks, and which should fulfill the exacting conditions of such a molded sound record. This patent contains no instructions useful to anyone skilled in the art desiring to accomplish Aylsworth's results. On the contrary, as far as it contains any information, it suggests the employment of more stearic acid. This patented composition of Edison, as compared with that of Aylsworth, is for a different purpose and composed of different ingredients.

The next patent is that of Edison, No. 488,191, granted December 20, 1892, on an application filed January 19, 1889.

This patent contains no mention of carnauba-wax. This patent is for making a sound recording blank which shall be light, and suitable for transmission by mail. The specification saying

> "The object of this invention is to provide phonogram blanks or surfaces, for receiving sound records in a phonograph, which shall be of a convenient and simple form and can be cheaply and readily manufactured, and which will be adapted to be conveniently packed in boxes and enclosed in envelopes for transmission by mail" (page 1, lines 9 to 16).

It is difficult to conceive of a subject matter more remote from the invention of the Aylsworth patent than is this patent, so long as attention is confined to this art. The specification proceeds as follows:

> "The main feature of the invention consists in the use of thin flexible sheets of wax or wax-like material,

> which sheets either by themselves or combined with backings of other suitable material, are used as a recording medium in phonographs" (page 1, lines 17 to 22).

The object is to make a flexible sheet which can be rolled up or flattened out as desired.

The recording surface is

> "a mixture of asphalt with Japan wax or pitches made from the distillation of fatty oils or combinations of fatty acids, any of which materials are equivalents of wax for the purpose of this invention" (page 1, lines 41 to 45).

I understand that this patent was referred to by Mr. Cameron solely by reason of its use of the word "wax-like."

In 1889 (when this Edison application was filed) "wax-like" was used in this art as identifying substances which were amorphous, slightly cohesive, and adapted to be readily cut by a record style, as described in the Bell and Tainter foundation patent No. 341,214, at line 60, page 1, the amorphous character being especially emphasized in the Edison patent No. 430,274, at line 27, both of which patents I have already discussed. "Wax-like" at that time was used to indicate the properties desirable for a cutting or engraving method of sound recording, and has no reference to the chemical constitution or any other quality which the wax might have, useful for purposes outside of the phonographic art.

The characteristics of this Edison patent No. 488,191 are well set forth in its claim which reads:

> "1. A collapsible phonogram blank consisting of a cylinder of flexible material with separable sheets of flexible wax or wax-like material placed thereon, substantially as set forth."

Manifestly the molded sound record made from the Aylsworth composition has no resemblance to this collapsible flexible blank.

The next patent is that of Edison No. 406,576 granted July 9, 1889, on an application filed February 16, 1889.

This patent also relates to blanks (and not molded sound records) and it is specially intended as an improvement on the Bell and Tainter blank having a base or backing made of one material and a recording surface of another material. The specification says:

> "My invention relates to that character of phonogram blanks, which consist of a base or backing of one material, usually a molded material, and an outer surface or covering of another material which receives the sound-record." (Page 1, lines 8 to 12).

Concerning the outer sound recording surface the patent says:

> "I prefer to employ for the outer sound recording surface a thin coating of a metallic soap,—such as stearate of soda." (Page 1, lines 48 to 50).

For the core or interior portion of the blank he employs a compound consisting of asphalt (preferably Trinidad asphalt. such as street pavements are made of) and a small quantity of a softening material (which may be Japan wax, ozocerite, crude petroleum, turpentine, melted rosin or melted tar) and "a small percentage of a material which in solidifying shrinks or contracts greatly, such as certain waxes, and preferably carnauba wax." (Pages 1, lines 66 to 70).

He suggests using five to seven per cent. of the carnauba wax at line 75 page 1.

It is to be noted that this composition including carnauba wax is simply for making an interior core (which performs the office of the paste board tube foundation of Bell and Tainter) and which takes no part in the forming of the sound grooves or in reproducing the sound. It is simply a stiff supporting core. The carnauba wax is simply employed in making this core for its shrinking effect. Because, as the specification says,

> "The reason for this is that when asphalt is melted and poured into molds, it does not contract in hardening and it is therefore difficult to get it out of the mold again. By mixing from five to seven per cent. of carnauba wax with the asphalt a compound is formed which shrinks slightly in hardening, and can therefore be readily removed from the mold." (Page 1, lines 71 to 79).

The sole reason for the use of carnauba-wax disclosed by this patent, in making a core or foundation, is to cause the compound, consisting mainly of asphalt, to shrink. This is not the reason why Aylsworth uses carnauba wax, because the composition of the Aylsworth patent with the carnauba wax left out shrinks sufficiently to clear the mold.

This patent teaches nothing concerning how to make a surface suitable for sound reproducing purposes, much less does it contain any information useful to anyone skilled in the art trying to solve the problem of making an efficient and durable molded sound record capable of being used in any climate and at any season of the year.

This patent is of interest because it contains the last suggestion of the use of carnauba wax in the phonographic art preceding the

Aylsworth patent in suit. In spite of the activity in this art and the numerous attempts to improve it, as shown by the patents referred to by defendant's witnesses, and also by those referred to by Mr. Aylsworth in his answer to question No. 43 of his second deposition, carnauba-wax is not mentioned in any patent in this art between 1889 and 1903 so far as this record discloses or so far as I am aware. Carnauba wax here disappears for fourteen years as an ingredient attempted to be used in this art.

At and prior to 1889 three patents in the phonographic art mentioned carnauba wax. The Tainter patent No. 421,450 contained a casual reference to carnauba wax, assigning no utility for it; the Tainter patent No. 393,190 suggests its use with beeswax in varying proportions varying from fifteen to forty per cent., dependent upon the season of the year, to improve sound recording blanks which had theretofore been too sticky and too soft for being efficiently cut by a record stylus; and the Edison patent No. 406,576 suggests carnauba wax as an ingredient for causing asphalt to shrink in making an interior core of sound-recording blanks whose recording surface was made of a metallic soap.

Not one of these three patents is for a molded sound record nor contains any information which would suggest to anyone skilled in the art that carnauba wax could be usefully employed in a composition for making molded sound records.

Instead of the art of the subsequent years, prior to Aylsworth, proceding on the basis of these patents, naming carnauba wax, there was a departure from them and the art trended in a different direction. In all three of these patents mentioning carnauba wax there was a base or foundation of one material acting as a support for a thin coating surface of another material in which the sound grooves were to be cut. Such sound recording blanks became obsolete and were superseded by the metallic soap blanks and carnauba wax as an ingredient ceased to attract the attention of those at work in the phonographic art.

The next patent is that of Edison No. 484,583 granted October 18, 1892, on an application filed May 27, 1890.

This patent is for a phonographhic cutting tool and the novel feature set forth consists in making the cutting or engraving tool of a phonographic sound recorder, of a jewel, preferably a sapphire. It contains no suggestion of any improvement or change in the character of the blank to be cut. Its reference to a blank is

> "The record surface of the phonogram blank is ordinarily of wax or a stearic or hard metallic soap or other wax-like material or composition" (page 1, lines 22 to 26).

This patent is apparently referred to solely because it contains the expression "wax-like," and as I have heretofore stated, this term was then used in the art solely for the purpose of identifying those properties of a material which rendered it suitable for being cut by the stylus of a sound recording machine, and had no reference to any property of a wax which might be availed of in some other art. This is rendered particularly plain in this patent which refers to "hard metallic soap or other wax-like material," thus ascribing the "wax-like" properties to a hard metallic soap.

This Edison patent has nothing to do with making molded sound records.

The next patent is that of Berliner, No. 548,623, granted October 29, 1895, and filed March 18, 1893.

This patent makes a sound record in a different way from anything heretofore discussed. According to this patent a flat sound record is made upon a zinc disk into which a spiral record of sound waves is etched, as stated at page1, lines 26 to 28. Duplicates are made from this etched zinc disk by pressing hard rubbed or celluloid against the same when softened by heat.

There is no suggestion of carnauba wax and no suggestion of any composition having any analogy to that of the Aylsworth Patent in suit.

The next patent is that of Macdonald, No. 606,725, granted July 5, 1898, on an application filed November 27, 1896.

This patent deals with obtaining a suitable blank, the specifications saying:

> "This invention relates to the manufacture of tablets or blanks adapted to receive engraved records of sounds and more particularly to the composition of matter of which the tablet is composed" (page 1, lines 8 to 12).

This patent has nothing to do with making molded sound records but only with making the blank suitable to be engraved in a sound recording machine. There is no mention of carnauba wax. Two compositions are given as Formula A and Formula B. Formula A is composed of stearic acid, aluminic hydrate, caustic-soda lye and either paraffine, ozocerite, or ceresin. Formula B is composed of stearic acid, caustic-soda lye, sal-soda, powdered aluminium and either paraffin, ozocerite or ceresin. Each of these compositions, as produced by the methods set forth, is a metallic soap.

The next patent is that of Macdonald, No. 626,709, granted June 13th, 1899, on an application filed August 23rd, 1898. This is simply an improved process for treating the identical metallic soap composition of Formula A of the preceding Macdonald patent, No. 606,725, and there is no change in the ingredients or their proportions. The improvement consists simply in using a higher degree of heat, whereas in the process of patent No. 606,725, 330 degrees F. was not exceeded, this second process contemplates using a temperature of about 460 degrees F. This patent is for making "blanks or tablets upon which sound records may be cut or engraved" (page 1, lines 9 and 10); it does not mention carnauba wax, and it contains no information concerning making molded sound records or any composition intended therefor.

The date of this latest patent application is August 23rd, 1898. The only prior application in this art in which carnauba wax had been mentioned were the two Tainter applications filed in November, 1887, and the one Edison application filed in February, 1899. Thus, for a period of over nine years the patent applications in this art, which were numerous, contained no reference to carnauba wax. As a possible ingredient it had ceased to have any attention. Again, during a period of over ten years no further attempts had been made towards producing molded sound records. The application for the Edison patent, No. 484,582, on the split mold had been filed in January, 1888, and had no successors and had made no impression on the art. The commercial way of making duplicate records from the engraved or master-record was by a mechanical duplicating machine, concerning which method of duplication, Mr. Cameron, one of defendant's witnesses, in answer to *xQ*. 50, says:

> "My first knowledge of molded records made by the American Graphophone Company was during the time when they were using the mechanical duplicating process. By that process a record was employed as a master to direct the action of a cutting style in contact with a blank of wax-like material, whereby a duplicate was cut in the blank corresponding in every particular with the original record. I had known for sometime that one of the difficulties or objections lay in the fact that the master records employed for this purpose rapidly wore out when used in this mechanical duplicating process so that only a limited number of duplicates could be made from a single original before it was destroyed by wear."

Not only did this mechanical duplication quickly wear out the master-record so that only a few good copies could be made, but as the duplicates were made by an engraving tool the same metallic soap composition was used for the duplicate as for the master-record with the result that they had the same limited length of life as the masters, so that in the hands of a customer a duplicate sound record could be used only a limited number of times.

In spite of the fact that carnauba wax had been mentioned in 1887, and that Edison had suggested the molding method of duplication in 1888, nevertheless, the contention of defendant's expert witnesses (as I understand it) is that it was at once apparent to any person skilled in this art that the mere addition of carnauba wax to a metallic soap would give the composition all of the desirable qualities needed for making molded sound records and that such use of carnauba wax was inevitable.

The inference that I draw from this historical resume of the prior art is exactly to the contrary effect. If the whole subject had been obvious since 1887 and 1888, or at least since July 30th, 1888, when Edison applied for patent No. 430,274, on the metallic soap composition, it is inconceivable that the commercial art should have clung to the defective mechanical duplicating process, especially since so much inventive thought was given to this art, as shown by the numerous patents granted in the interim, among which are those referred to by Mr. Aylsworth in answer to *Q.* 43 in his second deposition.

Moreover, the invalidity of this contention of defendant's expert witnesses is persuasively established by the attempts to make molded sound records in the years immediately preceding the invention of the Aylsworth patent in suit.

Mr. Cameron's position is thus summarized at the conclusion of his answer to *Q.* 10—

> "Answering your question therefore in a single sentence I would say that the teachings of the prior art would tell the expert that he could harden the material of the Macdonald patent No. 626,709 by adding carnauba wax thereto in proportions varying from a small percentage up to fifteen per cent. or higher, and that this hardening effect could be obtained without interfering with or detracting from the desirable properties of the composition for molded sound records."

I understand that Prof. Charles E. Munroe, another of defendant's experts, expresses substantially the same opinion in his answers to questions 5 and 11.

In other words, given the metallic soap composition and the mode of procedure of the Macdonald patent No. 606,725 filed November 27, 1896, or the improved Macdonald patent No. 626,709, filed August 23d, 1898, it was inevitable that carnauba wax would have been added if it was desired to make a molded sound record.

The history of the art intervening between 1898 an the date of the invention of the Aylsworth patent in suit is instructive in this connection.

I note, in the first place, that Mr. Macdonald, (the patentee of the two patents No. 606,725 and No. 626,709, just discussed) and who testified on behalf of the defendant, had knowledge of carnauba wax, because he says in answer to *Q.* 13:—

> "In 1898, when we were using the original 'masters' in our duplicating machine, we found they wore out in from twenty to thirty reproductions. In experiments directed to prolong the life of those masters I used carnauba wax for the purpose of hardening the original master record. This, for the purpose of making it wear longer under the reproducing stylus in the duplicating machine."

Mr. Macdonald does not state the success of this experiment, nor does any other witness testify with respect to the same. Certainly, moreover, having made this experiment with carnauba wax in 1898, it would have been inevitable that Mr. Macdonald, of all men, should have tried carnauba wax in connection with molded sound records on his taking up the subject of molded sound records if the present contention of defendant's expert witnesses is correct. I shall refer shortly to what Macdonald actually did in trying to make molded records, and that he did not use carnauba wax.

Also, Mr. Edison knew about carnauba wax, because in 1898 he suggested it, and if the contention of defendant's expert witnesses is sound, he must have inevitably used carnauba wax on again taking up the molded sound records.

Certainly, it is beyond dispute that Mr. Edison is a person skilled in this art, and at least the defendant will not deny that Mr. Macdonald is a person skilled in this art.

Now, the patented art referred to by defendant's witness shows that after 1898 (certainly the metallic soap composition had been brought to its highest degree of perfection for blanks to be engraved either in the sound recording machine or in the duplicating machine) and before the Aylsworth invention, several patents had been applied for on attempts to make molded sound records.

The first of these patents is that of Mr. Edison No. 607,662 granted February 5, 1901, on an application filed May 8, 1900. The specification of this patent says that the invention "relates to improved process of duplicating phonographic records" (page 1, line 10)); it refers to the prior Edison patent No. 484,582 on the split mold; and it states that the present object "is to provide a process wherein the production of the duplicate record will be facilitated and wherein the character of the resulting duplicate will be improved, since the mold used is continuous on its bore." (page 1, lines 21 to 26).

The specification then says—

> "My present process depends upon the fact that after a molten metallic soap or a mixture of soaps or other suitable material has been introduced within a mold carrying the representation of a phonographic record in relief on its bore and allows it to set, a sufficient contraction of the resulting duplicate can be secured as to permit of a longitudinal separation of the duplicate from the mold, whereby a continuous mold can be employed for carrying on the process." (page 1, lines 27 to 37).

The sole reference to the composition used is contained in the foregoing paragraph, and the sole material described is disclosed, and it is "a molten metallic soap." The further reference to "a mixture of soaps or other suitable material" being insufficient to convey any definite information.

That is to say, the only disclosure is the use of a then known metallic soap such as was in common use for making blanks to be cut either by the sound recording machine or by the duplicating machine.

Certainly, if the employment of carnauba wax was inevitable and what any persons skilled in the art must necessarily have done, this Edison patent must have contained a description of the use of carnauba wax. But it does not.

The next patent is that of Miller and Aylsworth No. 683,615, granted October 1, 1901, on an application filed July 31, 1900. This patent was also for a method of duplicating phonographic record by casting the material in a hollow mold. The sole reference to the material used is contained in the following sentence.

> "11 represents a tank which contains, as indicated, a proper supply of suitable wax-like material from which

> the duplicates are to be made and which material may be the ordinary commercial phonographic composition now in use." (Page 1, line 100).

This patent contains no reference to carnauba wax, it simply attempts to use the ordinary soap mixture used for making blanks. Evidently, the utility of carnauba wax in such a composition for molded sound records escaped these patentees in spite of the alleged inevitableness of the employment of carnauba wax. Manifestly, the Tainter suggestion in 1887 of mixing carnauba wax with beeswax in varying quantities depending on the season of the year, to make a thin surface coating for an interior paper tube, and Mr. Edison's suggestion in 1889 to mix from five to seven per cent. of carnauba wax with Trinidad asphalt, reduced in its melting point, by Japan wax, or ozocerite, or crude petroleum, or turpentine, or melted rosin, or melted tar, for making an internal stiff core to support an outer surface material to be engraved, conveyed no information to Miller and Aylsworth which they utilized in their attempt in 1900 to make a molded sound record.

The next patents are three patents of Macdonald, No. 682,991, granted September 17, 1901, on an application filed November 3, 1900, and reissued patents No. 12,095 and No. 12,096, both dated March 10, 1903.

These three patents constitute a disclosure of a single invention. Re-issued patent No. 12,095 simply corrects an error in patent No. 682,991, which refers to a "centigrade" scale at line 69, page 1, while the re-issue corrects this to "Fahrenheit" scale, at line 69, page 1. This original patent and its re-issue are for the process, while re-issue No. 12,096 is for the sound record made by the same process. The process is a molding one and the sound record is composed of a mixture of stearic acid and ceresin as stated at line 2, page 2 of re-issue No. 12,096, at line 4, page 2 of re-issue No. 12,095 and at line 104, page 1 of the original patent No. 682,991. This is the only mixture disclosed, although the patents make the broad statement:

> "I fill the mold (through funnel 4) with the melted material, (soap mixture or the like), which is hereinafter for convenience designated 'wax,' though I do not limit myself to a waxy composition, since any suitable material or composition that can be readily handled may be employed and will come within the scope of my invention." (Re-issue 12,096, page 1, lines 54 to 61).

This is in accordance with the customary plan of endeavoring to extend the scope of the patent. The only specific disclosure is that of a mixture of stearic acid and ceresin.

These three patents appreciate the desirablity of making a molded sound record harder than a blank which is to be engraved or cut, so that it may be more durable, although not as suitable for engraving or cutting purposes. For example, re-issue No. 12,096 says:

> "Among the superior advantages of my case-hardened record so produced are that the mass being denser is less liable to be affected by changes of temperature and moisture and that being harder it is not so readily worn out by the action of a reproducing stylus. Besides, while it would be difficult to engrave a satisfactory original sound record upon a surface as hard as that produced by my process, yet by this process a sound record nearly as good as an original record is readily and cheaply produced in a more durable condition;" (page 2, lines 28 to 40).

This extract refers to the record as being "case hardened" this is the result of the peculiar method described. After the cast has been made in a mold it is suddenly chilled at the outside and the specification says—

> "* * * * the first effect of this sudden exterior chilling is an initial reduction of the temperature to a point below the solidifying point of the harder ingredient, which is thereupon connected into a thin shell or film while the softer ingredient (still remaining liquid) is consequently forced inward" (page 2, lines 6 to 12).

The motion of this patent is that the completed sound record will have the harder stearic acid on the outside and the softer ceresin on the inside.

No one of these three patents says anything about carnauba wax. According to the present theory of defendant's expert witnesses (after having the Aylsworth patent in suit), anyone skilled in the art would have known inevitably as early as 1898 at least that the addition of carnauba wax to the ordinary blank soap composition would give the ideal composition for making molded sound records. But, Edison did not know this in May, 1900, nor did Messrs. Miller and Aylsworth know it in July, 1900, nor did Mr. Macdonald know it in November, 1900. On the contrary, instead of Mr. Macdonald taking the ordinary metallic soap blank composition and mixing carnauba wax with it, he discloses a composition of stearic acid and ceresin and expects, by a sudden surface chilling operation that the harder of the two materials will remain sufficiently on the exterior to give a hard and durable sound reproducing surface.

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The logical inference to be drawn from the history of the art is that it was not known what the effect of mixing carnauba wax with the metallic soap blank composition would be nor that it would be available in making molded sound records.

These three Macdonald patents represent the ultimate development reached in the art prior to the Aylsworth invention and as the outcome of the available knowledge of the art, Macdonald produces a molded sound record composed of stearic acid and ceresin, wherein a hard durable surface is supposed to be secured by sudden chilling of the exterior surface of the mold with the expectation that the hard stearic acid will wholly, or chiefly, constitute the outer surface of the sound record.

Briefly summarized the important steps in the history of the art were as follows:

(1) The origination of the phonographic art by Mr. Edison in 1877.

(2) The invention of the cutting or engraving process in connection with a blank having a wax-like surface composed of beeswax and paraffine suitable for being cut.

(3) The suggestion by Mr. Tainter in 1887 of mixing carnauba wax with ozocerite as a surface coating for a paper foundation, to make a blank, with no suggestion of how or why the carnauba wax is to be used; followed immediately by the suggestion of Mr. Tainter of a mixture of carnauba wax and beeswax in varying quantities, depending on the season of the year, to make the thin outer coating, spread on a pasteboard foundation, for a tablet or blank to be cut or engraved, the carnauba wax hardening the composition and making it less sticky; also in 1899 Mr. Edison's suggestion of the employment of from five to seven per cent. of carnauba wax with Trinidad asphalt and other materials for the purpose of preventing the Trinidad asphalt from sticking to the mold, the object being to make a stiff core for the material to constitute a blank to be cut or engraved; the suggestion bore no permanent fruit but was succeeded and replaced by other materials.

(4) The materials which succeeded and became the commercial composition for a phonograph blank to be cut or engraved was the metallic soap invented by Mr. Edison in 1888 and subsequently improved, its ultimate form being disclosed in the Macdonald patent, No. 626,709, filed in 1898.

(5) Mr. Edison, in 1888, suggested making a molded sound record with a split mold, but this did not prove to be a commercial method of making duplicate records, since the plan actually

adopted was to make duplicates by a mechancial method of cutting or engraving, the same metallic soap composition being employed for cutting the duplicate as used in the original or master blank.

(6) In 1900 the problem of making molded records was again taken up by Mr. Edison and Messrs. Miller and Aylsworth, and Mr. Macdonald also appeared in this field. Mr. Edison and Messrs. Miller and Aylsworth tried the metallic soap composition used for blanks. Mr. Macdonald tried the material used by him, a mixture of two ingredients, stearic acid and ceresin, his method involving a sudden chilling of the mold with the view of bringing the harder stearic acid to the surface for the purpose of making the sound record surface hard, durable and unaffected by climatic changes.

In thus endeavoring to develop the molded sound record art, these inventors in 1900 did not use carnauba wax, and the obsolete suggestions of Tainter and Edison, then thirteen and eleven years old respectively, were utilized in no way by those inventors.

In addition, the patents referred to by Mr. Aylsworth in his answer to *Q.* 243 in his second deposition show that during the period preceding the Aylsworth invention and following Edison's invention of the art, numerous other inventors were at work and suggested various other compositions including a long list of ingredients.

Finally, Aylsworth perfected the composition of the patent in suit which involves the use of carnauba wax or its equivalent in connection with metallic soap having stearic acid in excess and preferably with lampblack as a coloring pigment. This composition proves to have every property necessary and desirable for such molded sound records; and the addition of the carnauba wax to the metallic soap composition does not injuriously affect any of the desirable and useful properties of the metallic soap composition for molding purposes.

Clearly, the prior art contained no teaching or suggestion that carnauba wax could be mixed with the metallic soap composition for any useful purpose; it did not indicate how the mixture should be effected, and it did not teach that carnauba wax was miscible with the metallic soap composition or would beneficially improve it for making molded sound records or would preserve its desirable and useful properties.

To state the matter exactly, the only suggestion of carnauba wax of any definiteness existing in the prior phonographic art is that of the Tainter patent, No. 393,190, because the earlier filed

Tainter patent, No. 421,450, merely makes the bald suggestion of using carnauba wax with ozocerite without telling how or why, and the Edison patent, No. 406,576, had nothing to do with a composition for either receiving or reproducing a sound record but was merely to be used as a stiff substance as a core or foundation for such a sound receiving surface material.

Accordingly, the only pertinent prior patent with respect to carnauba wax is the Tainter patent No. 393,190, which describes a thin coating for a paste-board foundation composed of varying proportions of carnauba wax and bees wax, depending upon the season of the year, for making a blank surface suitable to be cut or engraved by the recording stylus of a recording machine, the carnauba wax being employed because the bees wax alone was too soft and too sticky for sound recording purposes. No such reason exists for addiing carnauba wax to the metallic soap composition set forth in the Aylsworth patent in suit, because without the carnauba wax the metallic soap composition is hard enough for sound recording purposes, and is not too sticky, and when the carnauba wax is added to make a molded sound record its proportion did not have to be varied on account of the season, and any such variation would be wholly impracticable because by no foresight can a maker know at what season a molded sound record is to be used.

Tainter's variable composition of bees-wax and carnauba wax, as a surface sound recording material, backed by a paste-board core, contains no suggestion or intimation which would prompt anyone skilled in the art to use carnauba wax with metallic soap in endeavoring to make a molded sound record.

I fail, therefore, to find anything in the prior art to negative the novelty of the Aylsworth invention, or tending to show that Aylsworth, in making his invention simply availed himself of the inevitable and expected factors which may be individually picked out in prior patents.

Assuming, for the purpose of this discussion, that the sole purpose of the metallic wax is to harden the metallic soap composition, and ignoring the fact that in addition carnauba wax must be miscible with the metallic soap composition and must not interfere with the necessary and desirable properties of the metallic soap composition there is nothing in the prior art to guide Aylsworth in the selection of carnauba wax. Carnauba wax was merely one of the many ingredients which had been described in patents and which in common with many of the others had conferred no lasting benefit upon the art. Nevertheless, out of the possible suggestions of the art, Aylsworth has selected carnauba wax and has used it with other ingredients, combining them in the proper manner, so as to make a successful molded sound record.

It is unnecessary to discuss the pertinent claim of the Aylsworth patent in suit, because, as I understand, Mr. Cameron does not in his discussion of the claims in answer to *Q.* 14, contend that the subject matter of any one of them is present in any one prior composition, his contention being that the subject matter of each claim simply involves the mixture of no materials. All of the pertinent claims specify a metallic soap (or stearate of soda as the metallic soap, in claims 18, 19, 20 and 22). Combined with such metallic soap there is specified carnauba wax in claims 2, 5, 6, 12, 14, 18, 19, 20 and 22; there is specified a "hard wax" of which carnauba wax is typical in claims 1, 3, 4 and 10; and there is specified "a wax-like compound ether" which results from the treatment of carnauba wax or its equivalent at the high temperature described in the specification, in each of claims 7, 8, 9, and 16; in addition, each of claims 10, 12, 14, 16 and 20 specifies a black pigment. No claim of these specified compositions is found in the prior art and the history of the development of the art shows that the combinations specified in any one of these claims was not the result of a person skilled in the art selecting known materials for their known properties to secure a known and expected result.

Before closing this answer I will make brief reference to the Miller patent No. 178,319, dated June 6, 1876, referred to by Mr. Cameron in answer to *R-dQ*. 76, and to the Hart patent No. 418,917, dated January 7, 1890, referred to by Prof. Munroe in answer to *Q*. 8.

The Miller patent No. 178,319 is for a "water-proof boot and shoe polishing wax" made in accordance with the following formula:

| | | |
|---|---|---|
| Paraffine wax | 10 | pounds |
| Stearic acid | 6 | " |
| Beeswax | 4 | " |
| Ivory black | 2 | " |
| Lamp black | 1½ | " |
| Gum dammar | 3 | ounces |
| Pulverized sugar | 10 | " |
| High proof alcohol | ½ | gill |
| Spirits of turpentine | ½ | " |
| Bar soap | 3 | ounces |

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Nothing more foreign to the phonographic art than a boot and shoe polish, or any other composition more different from that of Aylsworth, it is difficult to conceive as citeable.

This Miller patent precedes in date the original invention of Mr. Edison; it preceded the entire development of the phonographic art and its first use occurs in 1907, as a basis for Mr. Cameron's opinion.

The Hart patent, No. 418,947, dated January 7, 1890, is for a cloth marking crayon which is asserted to be "equally efficacious in marking coarse and fine fabric and may be used on all kinds of materials" (line 45).

The composition of the crayon is as follows:

| | | |
|---|---|---|
| Carnauba wax, | 1 | pound. |
| Stearic acid, | 1 | " |
| Paraffine wax, | 1¼ | " |
| Pigment, | | Sufficient. |

The primary and important quality of a crayon is that it shall readily pulverize at its point as it is drawn across a surface to be marked so as to leave particles to constitute a visible mark. No such qualities are desirable in the molded sound record and, manifestly, it would never occur to anyone seeking to solve the problem of making molded sound records to find how cloth marking crayons are made.

Manifestly, when Messrs. Edison, Miller, Alysworth and Macdonald were at work in 1900 trying to make molded sound records, they got no useful suggestions from the shoe polish patent of Miller or from the cloth marking crayon of Hart.

*Q.* 5. I will ask you to assume that the following statement contained in the Aylsworth specification is correct:

> "When the carnauba wax is added to the soap mixture, the temperature of the mass is raised to about 450 degrees Fahrenheit and maintained until all foaming ceases, which usually takes about five hours. By thus subjecting the mixture to a relatively high heat a combination is effected between the alcohols of the carnauba wax and the excessive stearic acid present in the metallic soap composition, forming a hard, wax-like compound ether, which gives to the composition many of its desirable characteristics" (page 2, lines 90 to 101).

Making this assumption, state whether you find in the prior art any disclosure of a composition for making the molded sound records which has a hard, wax-like compound ether so made?

*A.* I do not.

The Tainter patent No. 421,450, which suggests carnauba wax, does not state how or at what temperature it is to be combined with ozocerite. It is stated in this patent that the crude ozocerite is to be concentrated by heating it to a temperature of 400 degrees Fahrenheit, and upwards, but the patent is absolutely silent as to the conditions under which the carnauba wax is to be added. In any event, the statement quoted in the question describes the hard wax-like compound ether as resulting from the presence of excessive stearic acid and carnauba wax, and this Tainter patent does not disclose the presence of any stearic acid.

The Tainter patent, No. 393,190, described a mixture of carnauba wax and beeswax, but does not state the temperature at which they are to be mixed nor the presence of any stearic acid, and hence does not describe the production of a hard, wax like compound ether resulting from the mixture of free stearic acid and carnauba wax at a temperature of about 450° F.

The remaining patent in the phonographic art mentioning carnauba wax is the Edison patent No. 406,576 which describes the making of a core or backing for a phonographic blank out of Trinidad asphalt, comprised with seven per cent. of carnauba wax and with either Japan wax or ozocerite, or crude petroleum, or turpentine, or melted rosin or melted tar, in unstated proportions; the temperature is not mentioned, nor is any stearic acid mentioned; there is no description of a hard, wax-like compound ether resulting from the treatment of stearic acid and carnauba wax at a temperature of about 450° F.

*Q.* 6. I call your attention to the next to the last paragraph of Mr. Cameron's answer to *Q.* 10 and ask you whether you agree with the conclusions there reached by Mr. Cameron.

In this paragraph Mr. Cameron says:

> "From the numerous teachings in the prior art, and particularly from the teachings of the Tainter patents Nos. 393,190, and 421,450, an expert in the art would know that if he wished to make the record material of the Macdonald patent No. 626,709 harder that he could do so by adding carnauba wax thereto?"

*A.* I do not agree with this.

The record material of this Macdonald patent is for blanks to be cut or engraved and there could be no reason for making such a record harder, because to do so would interfere with its use as a recording material. Nor would an expert know in advance what the effect of adding carnauba wax to the material of such Macdonald patent would be. The Tainter patent simply taught the addition of carnauba wax to ozocerite and to beeswax to make a thin surface coating backed by a pasteboard or similar foundation and the only useful objects specified by Tainter were by adding various proportions of carnauba wax a sound recording surface could be made usable at all seasons, and also avoiding the soft and sticky character of beeswax. No such reasons would suggest the addition of carnauba wax to a metallic soap composition which is already hard enough for recording purposes, is not sticky and is not affected by changes in temperature. For example, in the Macdonald patent, No. 606,725 (which is endorsed at page 1, line 60 of his patent, No. 626,709), Macdonald says:

> "The material, moreover, should be sufficiently hard to withstand ordinary handling, to retain perfectly its form and to resist the effect of ordinary changes of temperature. It should also be a stable compound or material in order that records made in it may be preserved for an indefinite length of time." (page 1, lines 20 to 27.)

The metallic soap composition has these properties, accordingly it never would have occurred to anyone to use carnauba wax for the purpose Mr. Tainter had in mind in connection with the metallic soap composition of the Macdonald patent, which relates to the manufacture of blanks to be cut or engraved in a sound recording machine.

Mr. Cameron continues:

> "He (the expert in the art) would know that this would not interfere with, but would possibly slightly increase the shrinking properties of the composition, from the teachings of the Edison patent, No. 406,576."

As a matter of fact, I understand from the testimony of Mr. Aylsworth in reply that carnauba wax has just the opposite effect, thus showing how unsafe it is to reason *a priori*. The metallic soap composition by itself shrinks sufficiently to clear the mold; the thing to be desired is to make the molded sound record durable and at the same time not to incorporate an ingredient which may interfere with the shrinking properties. The making of these molded sound records is a very nice problem since they bear on their surface the sound grooves which cannot thereafter be corrected and which must not be destroyed. *A priori* the shrinkage properties of carnauba wax might result in unequal or excessive shrinkage when used with a metallic soap, which might distort the sound grooves and render the product imperfect. Where carnauba wax was used for making a core, as in the Edison patent, No. 406,576, or in making a blank, as in the Tainter patent, No. 393,190, distortion and shrinkage were matters of little consequence because such blank cores and blanks could be subsequently turned down to the desired form, whereas a molded sound record cannot have its sound record surface changed.

Mr. Cameron continues as follows:

> "And, moreover, he (the expert in the art), would know from the same patent that it would not interfere with the limpidity imparted to the composition by the ceresin wax, moreover, he would have been taught by the Tainter patent, No. 393,190, that it would not interfere with the fine texture which would enable the material to be cut smoothly, and that the material would be free from the air and gas bubbles, because of the prolonged high temperature to which it was subjected."

I fail to see how the expert would have obtained all this information from the Edison patent, No. 406,756, or from the Tainter patent, No. 393,190. In making molded sound records "limpidity" (that is fluidity), is of the highest importance because the molten liquid must flow so as to conform to every minute variation on the interior surface of the mold, since the perfection of the sound record depends thereupon. The Edison patent, No. 406,756, is absolutely silent as to the effect of carnauba wax upon the limpidity of the Trinidad asphalt employed. Edison was simply molding a core which could be subsequently turned down to the proper size and shape if necessary. Whether or not, such a mixture would be sufficiently limpid for making molded sound records (if otherwise usable) is not disclosed by the Edison patent and is a matter of immateriality as far as that patent goes.

Finally Mr. Cameron says that the Tainter patent, No. 393,190, teaches the expert that carnauba wax does not interfere with the fine texture which enables the material to be cut smoothly, and he also states that the material made hard would be free from air and gas bubbles because of the prolonged temperature to which it was subjected.

In the first place this Tainter patent, No. 393,190, is wholly silent as to the temperature employed; and while it may be that carnauba wax mixed with beeswax which can be cut smoothly, such information is of no value to a person wishing to make a molded sound record which does not require to be cut at all on its exterior surface. If Mr. Cameron here has reference to the cutting of the sound record blank on the interior surface it is to be noted that that cutting is done while the material is still in a semi-plastic condition, and this Tainter patent, No. 393,190, is absolutely silent as to any such cutting. It is to be noted that in this Tainter patent, No. 393,190, the composition is "applied to the base or foundation of the tablet in any suitable way" (line 70), and that the "suitable way" here mentioned is that previously employed as earlier stated in the same patent which says:

> "In such apparatus the recording medium or composition (usually wax or a wax-like substance), is spread in a thin layer on a suitable base or foundation —such as paper or pasteboard—constituting what is termed the 'tablet'." (Lines 13 to 18).

In other words, Tainter's composition was spread on a pasteboard foundation, and there is not the slightest intimation that the composition was suitable for being cut while still in a plastic condition.

In connection with such matters it is dangerous to assert *a priori* what will happen when different ingredients are mixed together for the first time under such temperatures as are mentioned in the Aylsworth patent in suit.

There is no field in which prophecy is more uncertain.

As an illustration, a number of years ago I was one of the solicitors for Mr. Thomas L. Willson, well known as the inventor of the present way of making acetylene gas, now so commonly used in the headlights of automobiles, and had occasion to go to his home at Leaksville, N. C., to take his deposition in a patent office interference involving an electrical method of making aluminum bronze. In accordance with that controverted invention alumina (which is oxide of aluminum) and metallic copper were placed in an electric furnace. At the temperature developed the carbon of the furnace electrode, combined with the oxygen of the alumina and escaped as carbonic acid gas, while the aluminum, mixed with the molten copper, thus producing aluminum bronze. While I was at Leaksville, Mr. Willson showed me a peculiar material resembling coke. He told me that in an idle moment, having some lime conveniently at hand he wondered what would happen if he put lime in his furnace instead of alumina, lime being the oxide of calcium, as alumina is the oxide of aluminum. He thought that as in one case he got aluminum bronze, in the other he ought to get calcium bronze and as such an alloy was unknown he was curious to see what it might be. Accordingly he put the lime and copper in the furnace. The result was wholly unexpected. At the close of the experiment his copper was still there in the furnace and with it was this peculiar coke-like looking substance. A bucket of water was standing near and Mr. Wilson said "Watch what happens when I throw a piece of this stuff into the water." He did so, and immediately there was a violent ebullition. Mr. Wilson then threw a lighted match on top of the water and immediately the escaping gas took fire, volumes of thick black smoke arose and the gas had a garlic smell. I remarked that he seemed to have an excellent plan of making lamp black. He had not then discovered that under proper control a brilliant light could be obtained. At the close of the experiment that I watched the bottom of the bucket was covered with lime. Mr. Wilson then explained that evidently what had happened was that the calcium contained in the lime had combined with the carbon of the electrode thus making some sort of combination of carbon and calcium; and when the substance was subsequently thrown in the water, the carbon and the hydrogen of the water combined to form a combustible hydro-carbon gas, and the calcium had combined with the oxygen of the water, restoring the lime. Hence, the lime behaved very differently from the alumina under the same conditions. *A priori* Mr. Willson, judging from the oxide of the aluminum, expected to get calcium bronze from the oxide of calcium. As a matter of fact, he got something very different and created a new industry.

This incident serves to illustrate the danger of *a priori* conclusions.

Of course, after the event, it is easy to see what happened and why.

On another occasion a client discovered a certain natural product in Kentucky which was exactly the right consistency and had the right drying qualities for use as printing ink; naturally it printed a golden brown color. He interested people familiar with the printing ink art in the invention and they bought the patent expecting to have no difficulty in obtaining a black ink, which is the desideratum for general printing purposes. But no matter what they did, they could never get a satisfactory black ink. No matter how much lampblack or other black pigment they put in the material they could not exclude the golden bronze tint which persisted in spite of all they could do, and the project proved a failure. The expected did not happen.

Mr. Cameron's contention is based upon the assumption that because carnauba wax has certain effects in one situation, that it was necessarily known what its effect would be in another particular given situation. Such a contention is absolutely unsound.

*Q. 7.* I call your attention to Mr. Cameron's answer to *R-dQ.* 76, wherein he states that he finds in the Edison patent, No. 400,648, the use "with free stearic acid of a substance similar to carnauba wax," and ask you to state whether or not you agree with him?

*A.* This Edison patent, No. 400,648, is for a blank composed of one hundred parts of ceresin, twenty-five parts of beeswax and twenty-five parts of stearic acid. No statement is made as to the temperature at which they are made. Mr. Cameron makes the statement which he does on the ground that beeswax as used in this Edison patent is the equivalent of the varnauba wax as used in the Aylsworth patent in suit. I do not agree with this statement.

The Aylsworth patent sets forth an equivalent between beeswax and carnauba wax only in connection with the described process involving the incorporation of the wax together with the raising of the temperature to about 450 degrees F. The patent says that by thus subjecting the mixture to a relatively high heat a combination is effected between the alcohols of the carnauba wax and the excessive stearic acid present in the metallic soap composition, forming a hard wax-like compound ether which gives to the composition many of its desirable characteristics (page 2, lines 95 to 100). Now, the reference to the beeswax is as follows:

> "While I prefer in all cases to make use of carnauba wax, as described, yet I find that beeswax and Chinese wax and palm wax all contained alcohols somewhat similar to those of carnauba and by which substantially similar reactions take place. These materials may therefore be substituted for the carnauba wax, but always at a sacrifice in the desirable condition of the resulting product." (page 3, lines 31 to 39.)

In other words, beeswax is equivalent to carnauba wax only because it has certain alcohols which form analogous, wax-like compound ethers when treated in the specified manner. The equivalent depends upon the specified method being carried out.

As there is nothing in the Edison patent, No. 400,648, tending to show that a temperature approximating 450 degrees F.

is employed, there is nothing to indicate that any wax-like compound ether is produced as the result of the presence of beeswax and stearic acid and hence, nothing to indicate that the beeswax employed by Edison is the equivalent of the carnauba wax as employed by Mr. Aylsworth.

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ORANGE, N. J., Tuesday, March 12, 1907.

Met pursuant to adjournment.

Counsel present as heretofore.

ARTHUR S. BROWNE resumed the stand.

CROSS-EXAMINATION, by Mr. MASSIE:

*xQ.* 8. Complainant apparently contends that records molded from the composition described in the patent in suit were made and sold in the early part of the year 1902. Without either admitting or denying this date, I would ask you if any molded records were made earlier than that period and if so, how were the same made and of what composition?

*A.* I have no information as to what was done prior to 1902 except from the patents which I have discussed, and as stated in the depositions of this case.

The several patents which I have referred to in connection with molded sound records are as follows:

The Edison Patent, No. 484,582, filed January 5, 1888, describes making a molded sound record in a split mold and he suggests the use of "wax or wax-like material, resin, or plaster-of-Paris," and in addition "sheets of smooth material like waxed paper or tin foil" which are to be subsequently backed up by "a wax, resin or cement." In this patent the materials are either poured into the mold or, in the case of sheets of smooth material, they are pressed upon the surface of the mold by a plunger or otherwise. After the material is molded the sections of the mold are moved outward from the molded material so as to leave the molded material free.

The Edison patent, No. 667,662, filed May 8, 1900, uses "a molten metallic soap or a mixture of soaps or other suitable material." In this case the mold is placed over a tank containing the molten soap composition and by elevating a plunger a portion of the molten material is drawn up into the interior of the mold. In chilling, the soap composition contracts radially inward so as to clear the interior record surface of the mold and is then withdrawn longitudinally. In this case, the mold is not split, this being asserted in the patent as an improvement on the method of the prior Edison patent, No. 484,582.

The Miller and Aylsworth patent, No. 683,615, filed July 31, 1900, uses a "suitable wax-like material" which "may be the ordinary commercial phonographic composition now in use," thus referring to the metallic soap composition. In this case the mold is dipped into the molten soap composition and the material flows into the mold and collects on its interior record surface. The mold is an integral mold, and when the material chills it contracts, thereby clearing the mold, so that it is withdrawn longitudinally.

The three Macdonald patents No. 682,991 filed November 3d, 1900, and re-issued patents No. 12,095 and No. 12,096, both dated March 10, 1903, contain the same disclosure. These patents fill a mold "with the melted material (soap mixture or the like) which is hereinafter, for convenience, designated 'wax,' though I do not limit myself to a wax-like composition, since any suitable material or composition that can be readily handled may be employed and will come within the scope of my invention." The Macdonald patents further say "The composition at present employed" is "a mixture of two ingredients, as stearic acid and ceresin" this being the specific composition described. In accordance with this patent the melted composition is poured into the mold between the interior record surface thereof and an internal core having a spiral rib thereon. The mold is a one-piece mold. The material in chilling contracts and gets free from the interior surface of the mold so that it is withdrawn by a longitudinal movement relatively to the mold. The chilling is effected by cold water which flows around the exterior of the mold.

*xQ.* 9. Do you recognize as a fact that these patents you have just enumerated in describing the making of molded sound records contemplate the use for that purpose of materials or compositions employed for making the ordinary original sound records by the direct action of the talking machine? *A.* Yes.

*xQ.* 10. Referring to the first patent you named, Edison, No. 484,582, so far as you know was the mold there described a good and satisfactory mold sufficient to make good sound records at the present day, aside from the fact that it was split longitudinally? *A.* Yes.

*xQ.* 11. And so far as you know were were the sound records produced by pouring into that split mold the molten material described in that same patent faithful and correct counterparts of the mold?

*A.* I have no personal knowledge of the facts, but should question the perfection of the product aside from the defect due to the splitting of the mold. The patent expresses no choice as to the suggested materials referred to as "wax or wax-like material, resin or plaster of Paris." There is no statement that these materials are to be melted before being poured. All that it says is that the duplicates are produced by means of this mold "by pouring therein." The wax or wax-like materials which were known in the art at the filing date of this application were disclosed in the Bell and Tainter patent No. 341,214, dated May 4, 1886, which describes a compound of bees-wax and paraffine. I should question very much the perfection of a molded record made of plaster of Paris. What sort of a record would be made of resin, or of a mixture of bees wax and paraffine, I do not know.

*xQ.* 12. I assume that in order to pour these compositions into the mold they would have to be melted first. It seems to me that the three factors in making a molded record by this Edison patent No. 484,582 are first, the mold, second, the composition employed, third, the manner of getting the composition into the mold, and we may add, as a forth, the method of getting the record out of the mold. I understand that the mold itself could not give a satisfactory sound record because of the split in it, and that in your opinion the composition employed would not give satisfactory results So far as you know would the method of getting the composition into the mold, namely, melting it and pouring it in, be objectionable, that is, does this feature have anything to do with the conceded failure of this process?

*A.* Not that I am aware.

*xQ.* 13. Referring next to the second patent named by you, Edison No. 667,662, so far as you know was the mold therein described a good mold and would it suffice to make satisfactory molded sound records at the present day? *A.* Yes.

*xQ.* 14. So far as you know would the process of getting into the mold the composition referred to be a satisfactory process at the present day if employed with the composition of the patent here in suit?

*A.* I have no personal knowledge, but should have a doubt as to the efficacy of the described plan of pulling the molten metal upward into the mold by a plunger.

*xQ.* 15. That is you doubt whether sufficient material would be raised into the mold to produce a uniform mass of material against the matrix-surface? *A.* Yes.

*xQ.* 16. Assuming for the purpose of this question only, if you will, that the method described in Edison patent No. 667,662 of lifting the molten material up into the mold by means of a plunger would suffice when employed with the composition of the patent here in suit to raise the material in a substantial quantity uniformly over the surface of the mold, then so far as you know to the contrary, would that process give a satisfactory molded sound record at the present time and if used with the present Aylsworth composition?

*A.* I have no knowledge of the fact but I should have doubts that the plan disclosed would be an efficient one. This patent contemplates that the lifting plunger should also constitute a core for shaping the interior of the sound records; this plunger is apparently kept always hot and it would seem probable that it would interfere with the chilling of the molded record or at least render the chilling an impractibably slow operation, and possibly, also, the sound record would in chilling hug the core and make it difficult to remove.

*xQ.* 17. Your idea is that it is quite possible that if in casting sound records from the composition of the Aylsworth patent in suit there be a core in the center of the mold without any means of cooling this mold off, then the result would be either satisfactory or at least impracticable because the shrinkage of the composition might be interferred with or the material might become clamped around the core; is that correct? *A.* Yes.

*xQ.* 18. It is fair, is it not to assume that the factors in making sound records according to Edison's patent No. 667,662, are first the mold, second, the particular composition used, third, the manner of introducing the composition into the mold, and possibly, fourth, the manner of getting the record out of the mold? *A.* Yes.

*xQ.* 19. I understand that the mold itself of this Edison patent No. 667,662 is unobjectionable? *A.* Yes.

*xQ.* 20. But that in your opinion the manner of introducing the composition may be objectionable at least so far as the composition of the Aylsworth patent in suit is concerned? *A.* Yes.

*xQ.* 21. How about the composition or compositions indicated by that Edison patent; is that composition suitable for making sound records in accordance with the process set forth in that patent?

*A.* Yes, so far as the process is concerned, but not so far as the product is concerned. I understand, that, as far as carrying out that process is concerned, the material specified is efficient, but that the sound record produced is inefficient because lacking in the desired durability.

*xQ*. 22. Is this then a fair statement of the facts as you believe them to exist, namely, that if we assume, for the purpose of this discussion only, of course, that the sound records made by the Edison patent No. 667,662, are unsatisfactory, their unsatisfactoriness is due chiefly to the composition employed? *A*. Yes.

*xQ*. 23. And that it is not due to anything else except the nature of the composition employed, unless it be the particular matter of introducing the composition into the mold as set out in this Edison patent?

*A*. Yes, and I think the manner of getting the record out may be objectionable by reason of the presence of the interior core.

*xQ*. 24. As a person familiar with the literature of this art, on reading the Edison patent No. 667,662, do you understand that the composition therein referred to is substantially the composition described in the Aylsworth patent in suit except that carnauba wax has not been added and the resultant mixture subjected to the treatment described by Aylsworth, and lampblack is omitted? *A*. Yes.

*xQ*. 25. Please refer to the Miller and Aylsworth patent named by you this morning, No. 683,625; I presume that we may properly assume that there are four factors present here, namely, the mold, the composition, the manner of introducing the composition into the mold and the manner of removing the record ultimately. *A*. Yes.

*xQ*. 26. Is the mold of this Miller and Aylsworth patent substantially the same as the mold of the Aylsworth patent in suit, and could sound records that would be satisfactory at the present day be made by means of that mold and the composition of the Aylsworth patent in suit?

*A*. Yes; and the same with respect to the manner of getting the material into and out of the mold.

*xQ*. 27. So that if it be made to appear, or if we assume for the purpose of this question only, that the molded sound records produced in accordance with this Miller and Aylsworth patent are not entirely satisfactory, that fact must be attributed solely to the nature of the composition employed? *A*. Yes.

*xQ*. 28. Do you, from reading this Miller and Aylsworth patent, understand that the composition there referred to is the usual blank composition, that is to say, the composition of the Aylsworth patent here in suit in which there has been no addition of carnauba, with the subsequent treatment thereof, and no lamp black added. *A*. Yes.

*xQ*. 29. I understand that of your own knowledge you are unable to say whether or not satisfactory sound records have been made in accordance with the Miller and Aylsworth patent referred to. Assuming that they have not been made, can you explain why they would not be satisfactory or can you account for their defects?

*A.* I understand that the records made in accordance with this Miller and Aylsworth patent were unsatisfactory because lacking durability and because, on account of their light color, imperfections could not be readily detected, so that imperfect records would be sold which would be the cause of dissatisfaction to purchasers and would interfere with their sale.

*xQ.* 30. Assuming that your last answer is based on trustworthy information, what I wish to know is how do you account for the imperfections referred to in records made of the composition named in the Miller and Aylsworth patent and by the process of molding therein set forth?

*A.* I understand that it is inevitable that there will be a percentage of records in which some imperfections in the sound groove surface may occur through handling or otherwise. It is important as a commercial proposition that the completed records should be inspected before being put out on the market and where the records are all of light color imperfections may escape the notice of the inspector which will be observed in case the sound records are black.

And if the records made by this Miller and Aylsworth patent were perfect, they would nevertheless quickly wear out, just as would have been the case had they been made by the old duplicating machine.

*xQ.* 31. If I correctly understand your answer it is in substance as follows: First, some of the records made in accordance with the Miller and Aylsworth patent would be satisfactory and others would be imperfect; second, that owing to the color of these records it would be not an easy matter to detect which were perfect and which were imperfect; third, that these imperfections are due to handling, and fourth, that even the perfect records are not sufficiently durable; have I correctly stated your views?

*A.* Yes, but in addition, they may have imperfections due to other causes than handling. I understand that accidents may happen to the mold, and that the process may not be perfectly carried out. For example, it may be possible for the workman to not permit the material to remain in the mold long enough, and they may be withdrawn prematurely; and such variable conditions, due to the human element may result in imperfections in the sound grooves.

*xQ*. 32. Please assume that the composition of the Miller and Aylsworth patent No. 683,615 referred to is used with the mold there described and in the manner there described, that the same are used with perfect accuracy as set forth in the patent, that there are no accidents and no imperfections or defects due to handling or any other personal element, is it your testimony that under these conditions the records produced will be entirely satisfactory at the present day except for their want to durability?

*A*. Yes, that is my understanding.

*xQ*. 33. Please refer to the Macdonald patent No. 682,991, and to the two Macdonald reissued patents, which we may assume to disclose the same thing, as stated by you; the four factors as with the other patents, are, the mold employed, the composition employed, the manner of getting the composition into the mold and the manner of treating it subsequently and getting the record out, are they not? *A*. Yes.

*xQ*. 34. The mold itself is satisfactory and would make records that would be substantially perfect at the present day if used with the composition of the Aylsworth patent, in suit would it not?

*A*. Yes, so far as I am aware or am advised.

*xQ*. 35. If we assume (in order to avoid any controversy at this time on this point) that the composition referred to in this Macdonald patent is the same composition as we have called the ordinary blank composition, would you make the same answer with regard to the sound records produced by this Macdonald disclosure, as you have done with regard to the Miller and Aylsworth patent just now, namely that the personal equation be removed and if the process be carried out with faithfulness, the records produced would be satisfactory except for their want of wearing qualities?

*A*. Yes, except possibly as affected by the withdrawal of the molded sound record which, in this Macdonald plan involved a removal of the sound record from an internal core having a spiral rib. I have no personal knowledge as to how such an internal core with spiral rib would affect the withdrawal, but I should think that that plan might be objectionable both because of possible shrinkage of the record from the interior core and on account of possible difficulty in withdrawing the record, which would have to be unscrewed to detach it from the spiral rib of the core.

*xQ*. 35. Still assuming, if you will be so good, for the purpose of this discussion, that the composition used with the Mac-

Donald patent is the regular blank composition that we have already referred to, please state what effect, if any is produced by the application of the cold water around the exterior of the mold, that is, what difference if any this would produce in the result as compared with the result obtained by the Miller and Aylsworth patent No. 683,615, or the Edison patent No. 667,-662?

*A.* I do not know whether there would be any difference in the result. Macdonald's patents state that the effect of the Macdonald method when used with the particular composition specified, consisting of stearic acid and ceresin, is to case-harden the record by bringing the harder of these materials to the surface. Whether or not there would be any such effect produced with the ordinary metallic soap composition should be employed, I am unable to say.

*xQ.* 36. A while back, in discussing the Edison patent No. 667,662, you referred to the core which you thought would remain heated and you seemed to think that this might interfere with or affect the shrinkage and impracticably delay the carrying out of the process; what have you to say in this matter with regard to the presence of the core D in the Macdonald patent, assuming that the composition employed is the ordinary blank composition, the soap mixture?

*A.* Of course, such opinion as I have expressed in this connection is purely theoretical. If there is objection to the Edison core on account of its becoming heated, there would be less objection to the Macdonald core. Edison's core is plunged into the molten composition in the tank and hence gets heated. The Macdonald core gets heated only from the molten composition poured into the mold and it is in part chilled (though apparently irregularly) by the water flowing around the mold and which, as illustrated, would abstract heat from the bottom of the core. Possibly, there would be irregular conditions of temperature at different parts of the Macdonald core which might affect the product. Consequently, while avoiding criticism which may be urged against the Edison core, the Macdonald core might introduce a new disturbing factor on account of the variations in temperature in the different parts of it.

*xQ.* 37. If it be a fact that the immediate result of the admission of cold water around the exterior of the Macdonald mold is to cause the molten composition to be solidified and to pack against the matrix-surface, the material in a broad sense contracting radially outwards towards the matrix and away from the core—then in your opinion would the temperature or the variations of temperature that might be imparted to the core itself produce any appreciable effect upon the sound record?

*A*. Possibly not on the exterior of the sound record, but it might be the case that on account of irregularity in shrinkage due to the varying temperature of the core, it might be difficult to unscrew the chilled record from the spiral rib of the core, with the result of breakage of a percentage of the records and interference with the uniformity of the internal diameter of the ribbed portion of the records, thus causing them to fit badly on the mandril of the reproducing machine.

*xQ*. 38. After reading the entire specification of the Macdonald patent No. 682,991 and of the two Macdonald reissued patents, can you say whether you regard the reference therein to "the composition at present employed (which is a mixture of two ingredients, as stearic acid and ceresin), etc., as an attempt on the part of the specification writer to set forth a new composition, or merely a reference to indicate a composition which he supposed was at that time well known?

*A*. I do not know whether or not a mixture of the two ingredients, stearic acid and ceresin was a mixture at that time known. I understand, however, that the patentee refers to a mixture of these two ingredients as the one which he has employed in carrying out his method. The patent is directed to the method or process and to the characteristics of the sound records so produced and not to the composition employed.

*xQ*. 39. You will observe that Macdonald, about line 60 on page 1 speaks of "the molded material (soap mixture or the like)" my question is whether, upon reading this patent as a whole, you understand that the reference made in line 102 to "the composition at present employed," etc., to the mind of a person skilled in the art and familiar with patent literature, indicates a different composition, or is merely a reference to the same composition, namely, soap mixture or the like"?

*A*. A different composition. I understand that these Macdonald patents refer to a mixture of the two ingredients—stearic acid and ceresin—as the composition actually tried and used. I understand, further that the patentee did not desire to limit the scope of his patents to this particular composition but wanted to protect the practice of his invention, no matter what composition might be tried and found adapted to it, and therefore the patentee makes a broadening statement such as patentees habitually make, and he says that he fills the mold "with melted material (soap mixture or the like) which is hereinafter, for convenience, a designated 'wax,' though I do not limit myself to a wax like composition, since any suitable material or composition that can be readily handled may be employed and will come within the scope of my invention."

*xQ.* 40. That is, if the patentee Macdonald had said: "The composition employed (which is a mixture *containing* inter alia two ingredients as stearic acid and ceresin)" you would understand that he referred to the same ordinary soap composition; but because he says "a mixture *of*" instead of "a mixture consisting of inter alia" you think he in the second passage referred to something different from that named at the beginning of the same paragraph?

*A.* Yes, particularly because he refers to the composition at present employed as "a mixture of two ingredients, as stearic acid and ceresin."

*xQ.* 41. That is you understand from this quoted passage that he means "a mixture consisting of these two ingredients only but nothing else"? *A.* Yes.

*xQ.* 42. Have you observed in reading prior testimony given in this case that defendant's counsel has produced an exhibit sound record and a stipulation has been made that this record is the Columbia record (manufactured for the defendant herein by molding from the ordinary blank composition)? *A.* Yes.

*xQ.* 43. Did you understand from the testimony that this record Complainant's Exhibit, Early Columbia Molded Record shows no carnauba wax but was made from the ordinary blank composition, comprising the metallic soap, etc.?

*A.* I do not recall the evidence with regard to it.

*xQ.* 44. Upon the assumption that your qualifications to testify in this case consist solely with your familiarity with patent literature and other publications, and recalling your testimony this morning that those patents prior to the Aylsworth patent in suit which refer to molding sound records indicate the use for that purpose of the compositions employed for making original sound records by the direct action of the phonograph, I will ask you if from the patents or other literature you observed any statements or indications that would indicate the difficulty or objection to the use, with the regular blank composition referred to, of a substantial percentage of carnauba wax? *A.* No.

*xQ.* 45. Do you find in any of the patents in this art which you have examined, any specific naming of any material that is used expressly for the purpose of rendering the composition or mixture harder, and if so what material or materials are thus named.

*A*. It will take me some little time to run over the patents and I will do this after the adojurnment this afternoon and before to-morrow morning and be ready to answer the questions to-morrow morning.

*xQ*. 45½. Will you please state briefly how the mold is made in the Edison patent No. 484,582, in the Edison patent No. 667,662, and in tthe Miller and Aylsworth patent No. 683,615, which three patents have been referred to by you this morning?

*A*. In the case of each one of these three patents the mold is made by a so-called "vacuous deposit" method. The original or master record has a thin film of metal deposited upon it by revolving in a vacuum chamber in the presence of vaporized metal. The master record, with this film of metal on it is, then covered with a thicker coating of metal by electro plating; the eltcro-plated metal is then backed up by an outer solid metal and the master record is removed. In the early Edison patent the mold thus formed was split into longitudinal sections. In the two latter patents the mold is used in its integral form.

*xQ*. 46. You find the vacuous deposit process set forth, do you not in U. S. Letters Patent No. 526,147 granted September 18, 1894, to Thomas A. Edison upon an application filed January 28, 1884, serial No. 118,942, this application and filing date being referred to in the Edison patent No. 484,582 at page 1, line 23?

*A*. Yes.

> Defendant's counsel offers in evidence a copy of the Edison patent No. 526,147, referred to,
>
> Marked "Defendant's Exhibit Edison Vacuous Deposit Patent."

*xQ*. 47. Of course we cannot obtain the molded sound records without any mold. Is it not also the fact that if our mold or matrix be good in spots, but has blank spots or portions of its surface that are not true, counterparts of the original, that the sound record made therefrom will be commercially worthless?

*A*. Yes.

*xQ*. 48. Assuming that the investigators in this art had a composition suitable for casting cylinders but did not have a perfect matrix or mold of the sound record, it cannot be gainsaid, can it, that such persons could not produce satisfactory molded sound records, or that the production of such molded sound records would have to await the achievement of a perfect mold.

*A*. You are correct.

Adjourned until Wednesday, March 13, 1907, at 10:30 o'clock A. M., at Professor Stillman's Laboratory, Stevens Institute, Hoboken, N. J.

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PROFESSOR STILLMAN'S LABORATORY,
STEVENS INSTITUTE,
HOBOKEN, N. J., March 13, 1907.

Met pursuant to adjournment.

Counsel present as heretofore.

ARTHUR S. BROWNE, resumes the stand.

CROSS-EXAMINATION, by Mr. MASSIE:

*xQ.* 49. Will you please now answer cross question No. 45?

*A.* The Tainter patent No. 393,190, November 20, 1888, specifies carnauba wax as a hardening ingredient.

The Edison patent No. 400,648, April 2d, 1889, specifies stearic acid as the hardening ingredient.

The Edison Patent No. 713,209 granted November 11, 1902, on an application filed March 5th, 1898, says:

> "These blanks may, therefore, be made of a relatively hard material, such as asphalt, or of stearic acid or stearate of soda mixed with the varying proportions of fine precipitates—such as chalk, slaked lime or lampblack—or wax or resins may be used, such as sealing wax or shellac mixed with fine precipitates, like chalk—or polished ebonite, vulcanized hard rubber or celluloid may be used, or glue may be employed either alone or mixed with precipitates, such as chalk" (page 3, lines 8 to 18).

The Jones patent No. 727,960, granted May 12, 1903, on an application filed March 27, 1900, specifies rosin, as the hardening ingredient at page 1, lines 80, 81.

The Macdonald patent No. 682,991, dated September 17, 1901 (heretofore referred to), specifies stearic acid as the hardening material.

A number of patents refer to compositions as being hard without attributing to which particular ingredient the hardness is due.

The Edison patent No. 406,570, July 9, 1889, refers to the employment of "a material which is hard and brittle" and states that he uses "a hard composition—such as a hard metallic soap" (line 14), thus referring to the hard metallic soap but without specifying to which ingredient the hardness is due.

The Edison patent No. 406,571, July 9, 1889, contains a similar statement at page 1, line 17.

The Heysinger patent, No. 460,338, September 29, 1891, says "gutta-percha and resin melted together in equal parts, the proportions varying with conditions inherent in different samples, makes a composition hard and elastic at ordinary temperatures, but, soft, plastic and inelastic at a temperature from 110 degrees to 140 degrees F. and will answer the purpose very well" (page 2, lines 90 to 97).

The Edison patent No. 484,582 states that he uses a material "preferably too hard to be satisfactorily indented by the phonograph," and of the ingredients mentioned plaster of Paris appears to meet the requirements.

The Macdonald patent, 606,725, July 5, 1898, refers to the described metallic soap composition as one "which should be sufficiently hard to withstand ordinary handling" but does not specify to which one or more the specified ingredients the hardness is due.

The Aylsworth patent No. 676,111, June 11, 1901, says that "the ceresin may be omitted entirely if it is desired to produce a hard composition and the proportion of oleate of lead may be reduced to obtain the same end" and he further says that the "resulting blanks are absolutely not crystalline in character, hard, perfectly smooth, and more or less transparent" (page 1, lines 60 to 67). He does not state, however, to which of the ingredients the hardness is attributable.

I find there are a number of patents which refer to materials which are hard when in ordinary use but can be softened by heat, the record being then made and on cooling the material being hard for reproducing purposes.

The Harrington patent No. 392,953, November 13, 1888, specifies boiled tar, pitch, resin asphalt, and dental wax, at lines 43 and 44, page 1.

The Harrington patent No. 397,856, February 12, 1889, specifies celluloid, glue, wax, molasses, pitch, asphalt, or various glutinous or resinous substances, or two or more of such substances in combination; specifically mentioning a compound of celluloid mixed with mollasses and bees-wax, the celluloid and bees-wax being dissolved with ether or other solvent, before mixing (page 1, lines 31 to 40).

The Harrington Patents No. 399,264, and No. 399,265, both dated March 12, 1889, specify wax, resin, pitch, celluloid, glue, rubber, or their compound or equivalent.

The Harrington patent No. 464,476, December 1st, 1891, specifies the same ingredients as the two preceding Harrington patents.

The Lioret patent No. 528,273, October 30, 1894, specifies celluloid.

The Lambert patent No. 645,920, March 20, 1900, specifies cellulose or vulcanized rubber.

The Stevens patent 650,431 May 29, 1900, specifies rubber and celluloid.

*xQ*. 50. Please enumerate which of these patents granted prior to, say, January, 1902 (about the date on which it seems to appear that both parties hereto began to put out their molded sound records), name any material for this hardening purpose when used with a blank cylinder composition.

*A*. This question would exclude the Jones patent No. 727,960 although filed March 27, 1900, and the Edison patent No. 713,209, although filed March 5, 1898.

I understand that this question limits the matter strictly to patents in which a composition is employed which is to receive a sound record or is to reproduce it without any heating.

Unless you intend to exclude coatings on a paper foundation by "a blank cylinder composition" I should refer to the Tainter patent No. 393,190 which specifies carnauba wax.

The Edison patent No. 400,648 specifies stearic acid, and the Macdonald patent No. 682,991 also specifies stearic acid.

The other cylinder composition patents such as Edison No. 406,570 and 406,571, the Macdonald patent, No. 606,725, and the Aylsworth patent No. 676,111 simply refer to the composition as being hard but without specifying to which particular ingredient the hardness was due. As, however, these patents all refer to a metallic soap which contained a stearate, I think it may fairly be assumed that the stearate is the hardening ingredient.

The Heysinger patent No. 460,338 is in the same category as Patent No. 393,190, providing a recording surface for a stiffer foundation, and this patent specifies gutta-percha and rosin as constituting the hard material.

*xQ*. 51. Which of these patents names any ingredient as having the property of hardening a wax-like composition, the term "wax-like" in my question having the meaning attributed to it in the early stages of the art, in the Bell and Tainter Patents?

*A*. Those mentioned in the preceding answer excepting the Heysinger patent. I think the Heysinger patent should be excepted.

*xQ.* 52. The materials named in the patents referred to that were granted prior to January, 1902, and described therein as serving to harden a wax-like composition (as the term wax-like has been explained), are carnauba wax, stearic acid, and metallic soap; are they not? *A.* Yes.

*xQ.* 53. Please assume that at the dates suggested (January, 1902) a person skilled in this art was molding sound records by the processes of the Macdonald patent No. 682,991, and the Macdonald reissue patents No. 12,095 and No. 12,096, using therefor the composition described in the Macdonald patents Nos. 606,725 and 626,709; and please assume further that these sound records appear to be perfectly satisfactory, but that the demand was then made to have the sound records harder or more durable; and, recalling that the substances named in the patent literature as rendering wax-like compositions harder, are the three just named, to wit, carnauba wax, stearic acid, and soap composition; and recalling that there is already present in their assumed composition free stearic acid and also the soap composition. Under those assumptions, what ingredient does the patent literature indicate as suitable for rendering this composition harder.

*A.* I think that the conclusion of one skilled in the art, prior to 1902, desiring to render the metallic soap composition harder would be to either increase the proportion of the stearic acid employed or to use less ceresin or similar hydro-carbons. In this connection the Aylsworth patent number 676,111 describes such a metallic soap composition and says that the resulting blanks are hard, and further says that "The ceresin may be omitted entirely if it is desired to produce a harder composition" (page 1, line 60); this would seem to have been the logical mode of procedure.

*xQ.* 54. It appears from the complainant's testimony herein that carnauba wax is composed (to the extent of about 95 per cent.) of myricyl cerotate and free myricyl alcohol; and it further appears to be the complainant's contention that under the treatment called for by the patent in suit the myricyl cerotate is not apparently affected or broken up but that the myricyl alcohol combines with the free stearic acid; assuming these facts to be correct would you regard the resulting composition as *containing* carnauba wax as such; or would you not consider that it contained myricyl stearate and myricyl cerotate.

*A.* I am not a chemist and may not, therefore, have a correct view of the subject, but as I look at the matter, I think you are, on the assumption of the question, probably correct.

*xQ*. 55. Leaving out the last part of my question, which may appear to be more or less chemical in its nature, I will ask you, assuming that a substance (specifically, carnauba wax) when treated in a certain manner with certain other substances has one of its ingredients taken away from it and combined with some of the ther substances; then, would you say that the resulting composition contained that original substance, carnauba wax?

*A*. I should think not.

*xQ*. 56. Do you regard stearic acid, from the teachings of the patent literature in this art, as "a hard wax"?

*A*. I do not recall any statement in any of the patents which so refer to stearic acid, and I have no reason for expressing an opinion either one way or the other,

*xQ*. 57. Do you regard stearic acid as a "wax?" *A*. No.

*xQ*. 58. Passing by the question whether or not you regard stearic acid as a "wax" I assume that you regard it as "wax-like" as that term has been used in this art?

*A*. I do not know whether stearic acid by itself would constitute a wax-like substance because I do not know whether by itself it has those properties which are necessary to make it so considered. Certainly, however, as an ingredient in the metallic soap composition, the composition made with it as an ingredient is wax-like.

Cross Examination closed.

No Re-Direct examination.

Signature wavied.

Counsel for complainant considers it advisable at this time to place on the record a statement of his position regarding this case. It is essential that the testimony should be closed before the call of the calendar on the 26th inst. Therefore, counsel for the defendant is notified that Professor Stillman, whose testimony is to be taken immediately hereafter will be produced for cross examination at the Stevens Institute, Hoboken, on Saturday morning, the 16th inst., at 10.30 A. M., that date being suggested by counsel for the defendant, as satisfactory to him. If Prof. Stillman is not cross examined at that time he will be requested to sign his deposition. The direct testimony of Mr. Aylsworth and Mr. Dodd has been taken and these witnesses are now ready for cross examination. Counsel for defendant is notified that both Mr. Aylsworth and Mr. Dodd will be

> produced for cross examination at Orange March 18, inst., at 10.30 A. M., that date having been suggested by counsel for defendant, as satisfactory to him. If at that time Mr. Aylsworth and Mr. Dodd are not cross examined, they will be requested to sign their depositions.

Mr. Massie—Defendant's counsel states on the record that at the request of complainant's counsel he had reserved for this case all of last week; but that the examination of complainant's witnesses, Browne and Stillman, and the further direct examination of the witness Aylsworth were postponed by complainant's counsel at his own volition.

Mr. Mauro and Mr. Massie, counsel for defendants, have numerous pressing engagements in other matters, notably a cause to be argued within the next day or two in the United States Circuit Court of Appeals in the Third Circuit; nevertheless, we shall endeavor at least to commence the cross-examination of Prof. Stillman on Saturday, but it scarcely seems reasonable to think that a chemical expert whose testimony is given stenograhpically can be intelligently cross-examined on such short notice.

Defendant's counsel also thinks it well to note on the record that the cross-examination of the witness Aylsworth upon his first deposition in rebuttal, although apparently completed, was not completed, and it has been agreed that in cross examining Mr. Aylsworth upon his second deposition, questions proper as cross examination on the first deposition may be admitted.

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ORANGE, NEW JERSEY, August 1, 1907.

Present—FRANK L. DYER, ESQ., for complainant.

In the absence of Mr. MASSIE, the following depositions were taken pursuant to agreement with him, reserving all rights of objection and cross-examination.

JOHN H. MORAN, a witness produced on behalf of complainant, having been first duly sworn on oath testifies as follows:

By Mr. DYER:

*Q.* 1. Give your name, age, residence and occupation?

*A.* John H. Moran, 251 Park Avenue, Orange, New Jersey. Purchasing Agent for the Edison Phonograph Works, Edison Manufacturing Company, and National Phonograph Company. age 35 years.

*Q.* 2. How long have you been connected with these companies as Purchasing Agent? *A.* Since September, 1899.

*Q.* 3. What are your duties as Purchasing Agent for these corporations?

*A.* To purchase materials on requisitions from our factory in accordance with the requirements, and to see that invoices for such materials are properly passed through to the Auditing Department for payment, after proper record of the receipt of the materials has been shown.

*Q.* 4. Are you familiar with the purchase by the Edison Phonograph Works of raw materials intended for the manufacture of molded record compositions? *A.* I am.

*Q.* 5. Are you able to say what becomes of the material made by the Phonograph Works for this purpose?

*A.* I am. The materials are purchased by the Edison Phonograph Works and delivered to the Department of our factory commonly known as the Wax Room, where they are made up into molded record compositions and are then turned over to the National Phonograph Company.

*Q.* 6. Upon whose order have you always purchased these materials for the molded record compositions?

*A.* On the requests of Mr. David A. Dodd and by the authority of William E. Gilmore, General Manager of the Edison Phonograph Works.

*Q.* 7. Are you able to state what materials were purchased in the months of December, 1901, and January, 1902, for example, for use in the make-up of the molded record composition?

*A.* I am.

*Q.* 8. What were these materials?

*A.* Stearic acid, sal-soda, ceresin, carnauba wax, sheet aluminum and caustic soda.

*Q.* 9. Can you produce a voucher showing the purchase of stearic acid for this purpose in January, 1902? *A.* I can.

> The witness produces original voucher of the Edison Phonograph Works, No. 16410, for 16,599 pounds of stearic acid, amounting to $1825.89, to which is attached bills of R. G. Mitchell, dated January 24th, 1902, January 28th, 1902, and January 31st, 1902.

*Q.* 10. Are you able to identify the bills attached to the voucher to which you have just referred as originals, and can you identify the various signatures or initials thereon?

*A.* I am; I recognize the initials "F. E.," as being in the handwriting of Frank Evans, a clerk in the employ of the Purchasing Department, who checked these invoices against the factory requisitions for this stearic acid. The initials "J. S." are in the hand-writing of John Schneider, a clerk employed at that time in the Purchasing Department, and who certified to the correctness of the prices on these invoices. The initials "W. C." on two of these invoices, namely, that of January 24th and of January 28th, are in the hand-writing of William Cheshire, a clerk employed in the Purchasing Department and who certified to the correctness of the extension on these invoices and the initials "F. E." are those of Frank Evans, certifying to the correctness of the extension of the invoice of January 31st, 1902. Also, I identify the initials "W. C." as being in the hand-writing of William Cheshire, certifying that the goods on these various invoices were duly received. Those specified in the invoice of January 24th, were received on January 28th; those specified in the invoice of January 28th were received on January 31st, and those covered by the invoice of January 31st, were received on February 5th, 1902.

It is stipulated between counsel that the quantities of stearic acid referred to in the several invoices identified by the witness were shipped by R. G. Mitchell and Company on the dates of the respective invoices and were received by the Edison Phonograph Works on the dates appearing thereon, as above stated. In view of this stipulation the voucher with its accompanying invoices in question will not be introduced in evidence as they form a part of the records of the Edison Phonograph Works, but they are offered to counsel for defendant, for purposes of cross-examination.

*Q.* 11. Can you state whether or not the Edison Phonograph Works prior and subsequent to January, 1902, purchased other amounts of stearic acid and received the same for use in the manufacture of molded record compositions?

*A.* They have and the purchases have assumed very large proportions. As early as January, 1902, and prior to that time, the purchases of stearic acid for this purpose aggregated many thousand pounds each month, and such purchases have been continuously made up to the present time.

*Q.* 12. Can you produce any voucher showing the purchase of ceresin for the Edison Phonograph Works in the month of January, 1902?

*A.* I can. I produce voucher No. 16,332 of the Edison Phonograph Works, for $54.15, to which is attached an invoice from the Strohmeyer & Arpe Company, dated January 16th, 1902, for 442 pounds of ceresin at 12¼¢. per pound.

*Q.* 13. Are you able to identify this voucher as an original paper from any writing thereon?

*A.* I can, it is an original paper; I identify the initials "F. E." as the hand-writing of Frank Evans, a clerk employed in the Purchasing Department indicating that he checked this invoice against the factory requisition for ceresin. I also identify the initials "J. S." as the hand-writing of John Schneider, a clerk at that time employed in the Purchasing Department, indicating the correctness of the price contained in this invoice. I also identify the initials "W. C." as the hand-writing of William Cheshire, a clerk employed in the Purchasing Department, who attested to the correctness of the extension on this invoice. I also identify the initials "W. C." as the hand-writing of William Cheshire, who also attested to the fact that the goods were received by us on January 18th, 1902.

> It is stipulated between counsel that the quantity of ceresin referred to on the invoice identified by the witness was shipped by Strohmeyer & Arpe Company on the date of the invoice and was received on the date appearing thereon, as stated above. In view of this stipulation the voucher with its accompanying invoice in question will not be introduced in evidence as it forms a part of the records of the Edison Phonograph Works, but it is offered to counsel for defendant, for purposes of cross-examination.

*Q.* 14. Are you able to say whether the Edison Phonograph Works prior or subsequent to January, 1902, purchased other quatities of ceresin for use in the molded record composition?

*A.* I am, in fact I know that as early as January, 1902, and prior thereto, the purchases of ceresin aggregated many thousand pounds per month, and at the present time the purchases of this material are enormously larger.

*Q.* 15. Having reference now to purchases by the Edison Phonograph Works of sal-soda, can you produce any original voucher showing purchases of this material?

*A.* I produce original voucher No. 16,248 of the Edison Phonograph Works in amount $190.05, to which is attached one invoice of the American Oil and Supply Company covering 14 barrels of re-crystallized sal-soda weighing 5250 pounds at $99.75. The balance of this voucher is made up by invoices for goods purchased from the American Oil & Supply Company for other purposes.

*Q.* 16. Please refer to the sal-soda invoice which you have produced and state whether it is an original paper, and whether or not you are able to identify any of the initials or hand-writing thereon?

*A.* It is an original paper. I identify the initials "F. E." as the hand-writing of Frank Evans, a clerk employed in the Purchasing Department, indicating that he checked this invoice against the factory requisition for the amount of sal-soda covered by the invoice. I also identify the initials "J. S." as the hand-writing of John Schneider, a clerk formerly employed in the Purchasing Department who attested to the correctness of price as rendered on this invoice; and also, I identify the initials "W. C." as being the hand-writing of William Cheshire, a clerk employed in the Purchasing Department, who attested to the correctness of the extension of this invoice, and also the initials "W. C." as the hand-writing of William Cheshire, attesting that the goods were received at the factory on January 17th, 1902.

> It is stipulated between counsel that the quantity of sal-soda referred to on the invoice identified by the witness was shipped by the American Oil & Supply Company on the date of the invoice and was received on the date appearing thereon, as stated above. In view of this stipulation the voucher with its accompanying invoice will not be introduced in evidence as it forms a part of the records of the Edison Phonograph Works, but it is offered to counsel for defendant for purposes of cross-examination.

*Q.* 17. Is it a fact that the Edison Phonograph Works purchased other amounts of sal-soda before and after January 1st, 1902, than that covered by this particular invoice?

*A.* It is a fact that they have made such purchases ever since January, 1902, and prior thereto, and at the present time we purchased the material in enormously large quantities.

*Q.* 18. Please produce a voucher showing the purchase by the Phonograph Works in December, 1901, of caustic soda for use in connection with the molded record composition?

*A.* I produce original voucher No. 16,158 of the Edison Phonograph Works, to which is attached an invoice amounting to $23.52 dated December 27th, 1901, covering 448 lbs. of caustic soda at 5¼ cents per pound, shipped by the Welch, Holme & Clark Company.

*Q.* 19. Please refer to this invoice and state whether it is an original paper and whether you can identify any of the handwriting thereon?

*A.* It is an original paper. I identify the initials "F. E." as the hand-writing of Frank Evans, a clerk employed in the Purchasing Department of the Edison Phonograph Works, indicating that this invoice has been checked against the factory requisition for the material purchased. I identify the initials "J. S." as the hand-writing of John Schneider, a clerk formerly employed in the Purchasing Department, indicating that the price of the material as charged by the invoice is correct. I also identify the initials "W. C." as the hand-writing of William Cheshire, a clerk employed in the Purchasing Department attesting to the correctness of the extension on this invoice. I also identify the initials "W. C." as the hand-writing of William Cheshire, attesting that the goods were received at our factory on December 30th, 1901.

> It is stipulated between counsel that the quantity of caustic soda referred to on the invoice identified by the witness was shipped by the Welch, Holme & Clark Company, on the date of the invoice and was received on the date appearing thereon, as stated above. In view of this stipulation the voucher with its accompanying invoice will not be introduced in evidence as it forms part of the records of the Edison Phonograph Works, but it is offered to counsel for defendant for purposes of cross-examination.

*Q.* 20. Are you able to say whether the Phonograph Works has purchased any caustic soda subsequent to the date of this invoice for use in the molded record composition?

*A.* They have continuously purchased this material for that purpose, and at the present time the purchases of caustic soda for that purpose are very large.

*Q.* 21. Can you produce any original voucher showing purchases of aluminum for this purpose?

*A.* I produce original voucher No. 16,042 of the Edison Phonograph Works in favor of the Pittsburgh Reduction Company, amounting to $285.40, to which is attached invoices of the Pittsburgh Reduction Company of December 2, 1901, December 6, 1901, and December 11, 1901. These invoices cover a total of 752 pounds and two ounces of sheet aluminum at a price of 42 cents per lb. less 10% and aggregate $284.30, the discrepancy between $284.30 and $285.40, the total amount of the voucher, is made up by the fact that we are charged for boxing, the total of $1.10 for the three invoices.

*Q.* 22. Can you identify any of the initials or hand-writing on these vouchers?

*A.* I can. In the invoice of December 2d, 1901, I identify the initials "F. E." as the hand-writing of Frank Evans, a clerk in the employ of the Purchasing Department, indicating that the invoice has been checked against the factory requisition for this material. I also identify the initials "J. S." as the hand-writing of John Schneider, a clerk at that time in the employ of the Purchasing Department, attesting to the correctness of price as charged on this invoice. I also identify the initials "W. C." as the hand-writing of William Cheshire, a clerk employed in the Purchasing Department, attesting to the correctness of the extension of this invoice. I also identify the initials "W. C." as the hand-writing of William Cheshire attesting to the fact that this materal was received by us on December 11, 1901.

On the invoice of December 6th, 1901, I identify the initials "F. E." as the hand-writing of Frank Evans, a Clerk employed in the Purchasing Department, indicating that this invoice has been checked against the factory requisition for this material. I identify the initials "J. S." as the hand-writing of John Schneider, a clerk formerly employed in the Purchasing Department, attesting to the correctness of the prices charged on this invoice. I identify the initials "F. E." as the hand-writing of Frank Evans, indicating that the extension of this invoice is correct. I identify the initials "W. C." as the hand-writing of William Cheshire, attesting to the fact that this material was received by us on December 18th, 1901.

On the invoice of December 11, 1901, I identify the initials "F. E." as the hand-writing of Frank Evans, a clerk employed in the Purchasing Department, indicating that this invoice has been checked against the factory requisition for the material. I identify the initials "J. S." as the hand-writing of John Schneider, a clerk formerly employed in the Purchasing Department, attesting to the fact that the price as charged is correct. I identify the initials "W. C." as the hand-writing of William Cheshire, a clerk employed in the Purchasing Department, indicating that the extension of this invoice is correct. I also identify the initials "W. C." as the hand-writing of William Cheshire, attesting to the fact that this material was received by us in two separate shipments, one on December 13th, and the other December 23d, 1901.

It is stipulated between counsel that the quantities of sheet aluminum referred to on the several invoices identified by the witness were shipped by the Pittsburgh Reduction Company on the dates of the respective invoices and were received on the dates appearing thereon, as stated above. In view of this stipulation the voucher with its accompanying invoices will not be introduced in evidence as they form a part of the records of the Edison Phonograph Works, but they are offered to counsel for defendant, for purposes of cross-examination.

*Q.* 24. Can you state whether or not the Edison Phonograph Works before and after January, 1902, made other purchases of sheet aluminum for use in the molded record composition?

*A.* They have continuously purchased this material for that purpose since January, 1902, and prior to that time and such purchases have been in very large amounts, aggregating many hundreds of pounds each year.

*Q.* 25. Having reference now to the purchase of carnauba wax for use in connection with the molded record composition, will you kindly produce a voucher, showing the purchase of this material, for instance as early as December, 1901?

*A.* I produce original voucher No. 16052 of the Edison Phonograph Works amounting to $928.26, to which is attached several invoices of Smith & Nichols, one of which is dated December 2d, 1901, and covers the purchase of 2052 pounds of carnauba wax at 13c. per pound, amounting to $266.76.

*Q.* 26. Can you identify the initials or hand-writing on this invoice of Smith & Nichols?

*A.* I identify the initials "F. E." as the hand-writing of Frank Evans, a clerk employed in the Purchasing Department, indicating that this invoice has been checked against our factory requisition for material covered by it. I identify the initials "J. S." as the hand-writing of John Schneider, a clerk formerly employed in the Purchasing Department, attesting to the fact that the price as charged on the invoice is correct. I identify the initials "W. C." as the hand-writing of William Cheshire, a clerk employed in the Purchasing Department, indicating that the extension on this invoice is correct. I also identify the initials "W. C." as the hand-writing of William Cheshire, attesting to the fact that the goods on the invoice were received by us on December 4th, 1901.

It is stipulated between counsel that the quantity of carnauba wax referred to on the invoice identified by the witness was shipped by Smith & Nichols on the date of the invoice and was received on the date appearing thereon, as stated above. In view of this stipulation the voucher with its accompanying invoices will not be introduced in evidence as they form a part of the records of the Edison Phonograph Works, but they are offered to counsel for defendant for purposes of cross-examination.

*Q.* 27. Did you continue to purchase carnauba wax for the Edison Phonograph Works for use in connection with the manufacture of molded record compositions subsequent to December 1, 1901? *A.* I did.

*Q.* 28. Did you purchase carnauba wax from any one except Smith & Nichols? *A.* I did.

*Q.* 29. From whom?

*A.* Strohmeyer & Arpe Company, Baumoehl & Emerman, and O. S. Janney.

*Q.* 30. Take for example, the purchases of carnauba wax from Smith & Nichols, and without referring specifically to the vouchers, state in what amounts this material was purchased from them subsequent to December, 1901, up to November, 1903, when the application for the patent here in suit was filed.

*A.* I have before me original vouchers of Smith & Nichols (which may not, however, be all that there are), showing purchases of carnauba wax for this purpose, as follows:

| | | | |
|---|---|---|---|
| January, | 1902, | 1125 | pounds |
| February | " | 5138 | |
| March, | " | 10267¾ | |
| April, | " | 5440¾ | |
| May, | " | 8708 | |
| June, | " | 4288¾ | |
| October, | " | 5075½ | |
| November, | " | 5276 | |
| December, | " | 10269½ | |
| January, | 1903, | 15279½ | |
| February, | " | 10222¾ | |
| March, | " | 10342½ | |
| April, | " | 10211¾ | |
| May, | " | 10218 | |
| June, | " | 15676½ | |
| July, | " | 10976 | |
| August, | " | 15873¾ | |
| September, | " | 39659¼ | |
| October, | " | 5258¾ | |

The dates of the purchases given are in each case the dates of the vouchers and not the invoices.

*Q.* 31. What is the total amount of carnauba wax purchased by you from Smith & Nichols during the period between December, 1901, and October, 1903?

*A.* Very close to 200,000 pounds.

*Q.* 32. Are you able to state whether the various amounts of carnauba wax referred to were received by the Phonograph Works, and if so, when?

*A.* All the vouchers from which the amounts were obtained indicate that the receipt of the material was certified by my Department, and I have no doubt as to the correctness of that fact. In every case, the goods would be received within a few days after the dates of the invoices and always before the vouchers were made out.

> The several vouchers referred to by the witness showing the purchase of carnauba wax from January, 1902, up to and including October, 1903, are offered to counsel for defendant for the purpose of cross-examination.
>
> At the request of complainant's counsel it is stipulated for the purpose of this suit that if the proper official of Smith & Nichols of New York City were produced as a witness for complainant, he would testify that his house sold carnauba wax to the Edison Phonograph Works in the amounts and at the dates stated by the witness Moran as shown in the several vouchers referred to by the said witness.
>
> Defendant's counsel objects to *Q.* 4 in that it calls for the witness to state the purpose for which the materials were purchased by him and the use to which the same were put, and is therefore incompetent and secondary evidence.
>
> The same objection is made to *Qs.* 7, 11, 14, 18, 20, 24, 25 and 27. The answers to the said questions are objected to on the same ground, and the answer to *Q.* 32 is objected to on the ground that the same is absolutely conjectural and secondary, regarding matters of which the witness has no knowledge.

JOHN R. SHERMERHORN, a witness called on behalf of complainant, being duly sworn, testifies as follows:

By Mr. DYER:

*Q.* 1. What is your name, age, residence and occupation?

*A.* John R. Shermerhorn, East Orange, New Jersey, Assistant General Manager of the National Phonograph Company, age 44 years.

*Q.* 2. Have you held your present position since prior to January, 1902? *A.* I have.

*Q.* 3. Are you acquainted with the date when the National Phonograph Company first put molded records upon the market? If so, please state the course of events in this connection at the beginning of the marketing of these molded records?

*A.* Under date of January 6th, 1902, we handed and shipped to each of our various salesmen twelve molded records with instructions that on their forthcoming trip they should be shown and demonstrated to the trade at large. Under date of January 13th, 1902, we sent a circular letter to our jobbers apprising them that we were shipping them six molded records, express paid, no charge, intended as samples of the product we proposed marketing on or about February 1st, 1902. On the same date, we mailed to the trade at large a printed circular and a catalog of such records as would be ready for shipment on or about February, 1902. The six records mentioned in the circular letter to the jobbers were shipped from our factory under date of January 13th, 1902, as the circular letter indicated.

*Q.* 4. Can you produce a copy of the printed circular mailed to the trade on January 13th, 1902? *A.* I can and do.

*Q.* 5. Please read on the record from this circular such portions thereof as relate to the molded records.

*A.* "THE HIGH SPEED HARD WAX MOULDED EDISON RECORDS are made of an entirely new composition, much harder than the ordinary wax Record. They may be handled without fear of spoiling the surface with finger marks; they are not, however, indestructible. Their speed is 160 revolutions, higher than ever before successfully attempted on Standard size Records. To reproduce them perfectly, it is absolutely necessary that a Phonograph should run at the same speed, that is, 160 revolutions per minute and no more; the variation of a few revolutions making a vast difference in the reproduction. These Records are made from a permanent MASTER, and no care or expense is spared to make it perfect; consequently, *all* Edison Records made from this MASTER are exactly alike, and are *all* exact copies of the PERFECT MASTER for loudness, clearness, naturalness and depth of cut. Flaws and imperfections are a thing of the past."

*Q.* 6. Can you state whether or not these molded records were sold to jobbers and dealers in the United States on the date you have referred to?

*A.* Yes, orders for these molded records were filled from jobbers or dealers in the United States on or about February 1st, 1902, and since that date such records have been sold in enormous quantities.

*Q.* 7. When did you hear of the announcement by the Columbia Phonograph Company of its intention to sell molded records?

*A.* My attention was first called to the fact that the Columbia Company intended to put a molded record on the market some time after the National Phonograph Company began to market its molded records. My attention was first called to a circular issued by the Columbia Company under date of February 5th, 1902, in which their molded record was announced, and in which it was said that:

> "Columbia records can be shaved, if desired, and the blank recorded upon. This is true of no other *new* record upon the market."

*Q.* 8. Having reference to the molded records which were first put on the market by the National Phonograph Company on or about February 1st, 1902, can you state who invented the composition from which such records were made?

*A.* I have always understood that the composition was invented by Mr. Jonas W. Aylsworth.

*Q.* 9. Did you have anything to do with the ordering of the materials for this composition?

*A.* Yes, many of the orders for the material passed under my direct supervision and were approved by me.

*Q.* 10. Can you state what materials were purchased for making the composition and in what amounts such materials were obtained?

*A.* We purchased enormous quantities (in the aggregate many thousand pounds per month) of stearic acid, ceresin, sal-soda, caustic soda, aluminum and carnauba wax. The purchase of these materials commenced sometime before February, 1902, when the Company was engaged in laying up a stock of records for sale.

> Counsel for Defendant objects to answer to *Q.* 3 as not responsive; to *Q.* 6 as incompetent, since it does not appear whether or not the records which were sold to dealers, as testified to in said answer, were "molded records," and also because it does not appear how the same were molded or of what composition and the said answer is therefore further objected to as being irrelevant, immaterial and incompetent; to answer to *Q.* 8 as incompetent and as being hearsay, and to answer to *Q.* 10 as incompetent since it does not appear for what purpose the ingredients were purchased.

Defendant's counsel declines to cross-examine.

Counsel for Complainant gives notice of the close of his rebuttal proofs.

(*Filed July 31, 1907.*)

PROFESSOR STILLMAN'S LABORATORY,
STEVENS INSTITUTE,
HOBOKEN, N. J., March 13, 1907.

Met pursuant to adjournment.

THOMAS B. STILLMAN, a witness called on behalf of complainant having been first duly sworn testified as follows.

DIRECT EXAMINATION by Mr. DYER:

*Q.* 1. Please give your name, age, residence and occupation.

*A.* My name is Thomas B. Stillman, my age 55. I reside at Hoboken, N. J. and am Professor of Chemistry, Stevens Institute, Hoboken, N. J.

*Q.* 2. What experience have you had in chemical matters qualifying you to testify as an expert in suits based upon patents involving chemical considerations?

*A.* I have acted as chemical expert in patent cases for the last 25 years. I graduated from Rutgers college in 1873, taking the chemical course and then taught chemistry for two years at Stevens Institute during 1874 and 1875; then I studied under Professor Fresenius at Wiesbaden, Germany, in chemical research for one year. In 1881, I became instructor of chemistry at Stevens Institute, at the same time retaining a laboratory for chemical practice at 40 Broadway, New York City, between the years 1877 and 1895. I am a member of the American Society of Mining Engineers, the American Chemical Society, the French Chemical Society, Paris, France, the German Chemical Society of Berlin, Germany, the International Society for testing materials, Zurich, Switzerland, the American Electro-Chemical Society, etc. In 1881 I was appointed Instructor in Analytical Chemistry at Stevens Institute and in 1886 I was appointed Professor of Analytical Chemistry at Stevens, which position I hold at the present day. During this period my work has been largely chemical work for various industries in the country, the examination of the chemical portions of patents, giving expert evidence as to the same, etc.

*Q.* 3. Have you read and do you understand the patent of Aylsworth for composition for making duplicate phonograph records dated February 14th, 1905, No. 782,375, being the patent in suit herein? *A.* I have and do.

*Q.* 4. Are you familiar with the composition and analysis of carnauba wax? *A.* I am.

*Q.* 5. The patentee states that carnauba wax consists "of a mixture or combination of the higher fatty acids and alcohols" (page 2, lines 81 and 82). Is this a correct definition of carnauba wax, in general language? *A.* It is.

*Q.* 6. The patent in suit refers to the manufacture of a metallic soap composition with free stearic acid and describes the addition to the same of carnauba wax; it says "When the carnauba wax is added to the soap mixture the temperature of the mass is raised to about 450 degrees F. and maintained until all foaming ceases, which usually takes about five hours. By thus subjecting the mixture to a relatively high heat, a combination is effected between the alcohols of the carnauba wax and the excessive stearic acid present in the metallic soap composition, forming a hard wax like compound ester, which gives to the composition many of its desirable characteristics," so far as the chemical reaction is concerned, namely, the reaction between excessive stearic acid present in the metallic soap composition and the alcohols of carnauba wax, is the patent correct in this respect?

*A.* It is.

*Q.* 7. Professor Holton and Professor Munroe, who have testified for the defendant herein state that as a fact the percentage of free myricyl alcohol in carnauba wax, is very small. Do you regard their views as correct in this respect?

*A.* I do not, no sir.

*Q.* 8. Can you refer to the literature of the art on the question of the amount of free myricyl alcohol in carnauba wax and state what previous investigators have found in this respect?

*A.* The investigations by H. Sturcke concerning the chemical ingredients of carnauba wax show very complete and thorough examination of this subject. The work performed by him is one of tedious investigation and of great thoroughness. He states that he has demonstrated by his own determinations that free myricyl alcohol in considerable quantities is contained in carnauba wax.

This article of Sturcke's is from Liebig's Annalen der Chemie, vol. 225, pp. 283 and 314, and was written in 1884.

In this very elaborate paper Sturcke refers to the previous investigation of Story-Maskylene who found that there was about 30% of free myricyl alcohol in carnauba wax and Sturcke confirms this result.

I find in a book entitled "The Analysis of Oils and Allied Substances" by A. C. Wright (London, 1903) at page 29, a statement as follows:

> "Carnauba wax is mainly composed of myricyl cerotate; it also contains free ceryl and myricyl alcohols, which must be present in considerable quantity, judging by the large acetyl value found by Lewkowitsch."

In, "Commercial Organic Analysis" by Alfred H. Allen (Philadelphia, 1889) vol. 2, part 1, pp. 228, I find the following statement:

> "Carnauba wax has a very complex composition. It consists of a mixture of higher fatty acids and alcohols together with the esters of these bodies. The free myricyl alcohol, and that obtained by saponifying the myricyl cerotate, together amount to 45% of the entire wax."

I observe that Professor Holton, defendant's expert, bases his opinion principally upon a book entitled "Chemical Technology and Analysis of Oils, Fats and Waxes" by Dr. J. Lewkowitsch (London 1904) which states that

> "Carnauba wax consists chiefly of myricyl cerotate and a small quantity of free cerotic acid and myricyl alcohol. The latter is easily removable by cold ethyl alcohol."

This statement by Dr. Lewkowitsch is erroneous in two respects. In the first place carnauba wax contains large quantities of free myricyl alcohol and in the second place myricyl alcohol is almost entirely insoluble in cold ethyl alcohol. The very slight solubility of myricyl alcohol in cold ethyl alcohol is confirmed by Sturcke who says in the article to which I have just previously referred "Myricyl alcohol is only very slightly soluble in cold ethyl alcohol." This fact is also confirmed by one of the very latest works on this subject, namely by Gustave Hester in his work "Technologie der Fette und Ole" (Berlin 1906) page 63, where he states that myricyl alcohol is almost entirely insoluble in cold ethyl alcohol.

I have further confirmed this fact by my own investigations.

Dr. Lewkowitsch is considered one of the best authorities on the analysis of oil, fat and waxes, but in getting up a book of this character, with his large private practice, he must make some statements, either by reason of haste or by depending upon assistants, who probably compiled the work with him, which are not absolutely correct.

*Q.* 9. In the book by A. C. Wright, referred to in the above answer you quote a statement in which reference is made to the "large acetyl value" of carnauba wax found by Lewkowitsch;

what was this acetyl value and what bearing if any has that fact on the amount of free myricyl alcohol present in carnauba wax?

*A.* The acetyl value as determined by Lewkowitsch was 55.24, and this value appears on the same page as the statement by Lewkowitsch which I above quoted relating to the "small quantities of free cerotic acid and free myricyl alcohol." This figure of the acteyl value, as determined by Lewkowitsch, shows that free myricyl, or other alcohol, must be present in considerable quantities.

*Q.* 10. Have you read the deposition of Prof. Holton taken in this case? *A.* Yes.

*Q.* 11. Prof. Holton denies the correctness of the chemical theories set forth in the patent and asserts that if there is any reaction between the free stearic acid and the free alcohol, or alcohols, or of the carnauba wax to form a compound ether, the amount of compound ester thus formed would be so small as to be negligible. Do you regard Prof. Holton's view in this respect as sound? *A.* I do not.

*Q.* 12. Have you made any experiments to determine the correctness of the chemical reaction set forth in the patent?

*A.* Yes, sir.

*Q.* 13. When did you make these experiments?

*A.* Between the dates of February 28, 1907 and March 12, 1907.

*Q.* 14. Will you briefly explain what these experiments demonstrated?

*A.* These experiments were undertaken to show that a chemical reaction takes place as specified in the patent when carnauba wax is added to the soap mixture and heated to 450 degrees F. The chemical reaction which takes place is indicated by frothing for a number of hours of the materials heated at this temperature. To determine whether this was a chemical reaction and not a physical one, the following experiments were made: The carnauba wax used in these experiments was purchased from Smith & Nicholls, 48 South street, New York City; the stearic acid, the caustic soda, the sodium carbonate crystallized, the ceresin and the sheet aluminum were all of first grade materials as sold in the market.

A batch of hard regular wax, that is the composition described in the specification of the Patent No. 782,375, on page 2, lines 27 to 78, was prepared to be used as a stock material for experiments. The object of thus making stock material was to gain in uniformity of product, and convenience. The mixture was composed as follows: 2,000 grammes of stearic acid; 430 grammes crystallized carbonate of sodium; 20 grammes caustic soda; 7.72 grammes of aluminum, 1668 grammes of water, being the exact proportions specified in the patent. The stearic acid used was purchased from the Century company of New York and contained about 50% of palmitic acid and 2½% of oleic acid. The stearic acid was first melted and heated to about 350 degrees F. and then filtered through heavy cloth; the carnauba wax was melted over water, washed a couple of times with boiling water and then allowed to solidify; this was then remelted and filtered and heated to about 450 degrees F. until all frothing stopped, which took about 20 minutes. The alumnium was dissolved in water containing carbonate of soda and caustic soda, by heating, and this was then filtered. The stearic acid was heated to 250 degrees F. and then the alkaline solution of aluminum slowly run in. The temperature was gradually raised to 350 degrees F. and when the soap formed was all melted and the violent frothing had stopped the temperature was raised to 450 degrees F., for one hour. The frothing had practically ceased. This soap was then allowed to cool.

## I.

### *Experiment to Determine the Amount of Water Vapor Given off during the Reaction of Carnauba Wax.*

Three distilling flasks of about 350 c.c. were immersed in a bath of molten stearic acid soap. These flasks contained the following:

Flask No. 1 contained 30 grammes of hard regular wax, *i. e.* metallic soap, made as above described. This had been previously heated to 450 degrees F. until no further action was seen.

Flask No. 2 contained thirty grammes of carnauba wax which had also been previously heated to 450 degrees F.

Flask No. 3 contained 30 grammes of hard regular wax, the same as the sample in Flask No. 1, and also contained thirty grammes of carnauba wax the same as the sample in flask No. 2; these were mixed in the flask.

A plug of glass wool was placed in the stem of each distilling flask to catch any fumes of stearic acid. A stream of nitrogen gas was passed over a red hot copper coil to remove any possible oxygen present, and then dried by passing through a calcium chloride tube; after passing the calcium chloride tube the nitrogen gas was passed into the three flasks, containing the molten material, by separate glass tubes. These flasks were securely stoppered. The gas then passed into test tubes each with a side neck, the tubes being filled with glass wool and immersed in boiling water. This was to remove any stearic acid fumes. The gas then entered weighed calcium chloride tubes which absorbed the moisture to be determined. The calcium chloride in these tubes was protected from absorption of moisture from the air by being connected with small glass tubes dipping in under strong sulphuric acid. The nitrogen gas was passed through the apparatus, displacing the air and all moisture therein, the flasks in the bath being maintained at a temperature of 280 to 300 degrees F. That was continued about two hours. At this moment the three calcium chloride tubes were weighed and again were replaced in position. The heat was then maintained for 45 minutes at from 280 to 300 degrees F. and the tubes again weighed. For three hours the temperature in the bath was maintained at from 430 to 440 degrees F. and the tubes were then again weighed. The heating was continued for two hours and twenty minutes further, the temperature being between 430 and 446 degrees F. and the calcium chloride tubes were then again weighed. After a final heating of three hours at a temperature of about 440 degrees F. the tubes were again weighed and the amount of moisture determined.

The amount of moisture obtained from the contents of flask No. 1 (the soap composition alone) : was .0704 grams.

From flask No. 2 (containing carnauba wax alone) the amount of water obtained was .089.

From flask No. 3 (containing the mixture of the metallic soap composition and carnauba wax) the amount of water obtained was .4095.

This experiment shows that in the case of metallic soap and carnauba wax, when heated alone, the total amount of water evolved was enormously less than was evolved when the metallic soap and carnauba wax were heated together. This would indicate an ester reaction showing a reaction taking place between the free mericyl or other alcohol and free stearic acid to form an ester, or compound ether, as stated in the patent.

Where I speak of stearic acid, of course I have reference to a mixture of stearic acid and palmitic acid.

I regard this experiment as a demonstration of this fact. In the case of the combination of the metallic soap and carnauba wax about two and one-half times as much water was evolved as the combined water evolved from the separate metallic soap and the separate carnauba wax.

One gram of water corresponds to 25.2 gramms of myricyl alcohol; thus, the water obtained from flask No. 3 (the mixture of metallic soap and carnauba wax) and weighing .4095 gramms, would correspond to 10.35 gramms of myricyl alcohol. If now, we subtract the amount of water evolved from flask No. 1 and from flask No. 2, from that obtained from flask No. 3, so as to get the water which cannot be due to anything except the formation of ester, we secure an amount of .2501 gramms of water. This corresponds to 6.3 gramms of myricyl alcohol, which is equivalent to 21% of the carnauba wax used in flask No. 3.

It must be understood that in these calculations I am giving the least possible amount of free myricyl alcohol present in the carnauba wax; the true amount may be very much larger for the reason that the operation may not have been entirely completed.

### 2.

### *Experiment to Determine the Amount of Free Stearic Acid Necessary to Form the Ester Reaction.*

Three portions were taken, as follows:

1. Hard regular *i. e.* metallic soap composition, 5.10 gramms.

2. Carnauba wax, previously washed and melted at 450 degrees F. and filtered, 1.05 gramms. The above being the proportion of the patent.

3. Hard regular (metallic soap composition), 5.10 gramms. Carnauba wax, 1.05 gramms.

In No. 3 the two were added together: in No. 1 there was soap alone; in No. 2 there was carnauba wax alone and in No. 3 there was a mixture of soap and carnauba wax.

These three samples were put in test tubes with side tube outlets, No. 1 being placed in the first tube, No. 2, in the second tube and the mixture, No. 3, in the third tube; the top of each tube was closed with a rubber stopper. These test tubes were connected to potash absorbent bulbs filled with alcohol; glass wool was placed in the tubes above the substance and also in the side outlet tubes. Then these tubes were heated together in the wax bath for three hours and the temperature maintained at 450 degrees F.

The resulting wax cakes were placed in separate Erlenmeyer flasks and each dissolved in a total of 250 c.c. of alcohol, in 5 portions of about 50 c.c. for each case, boiling each time with the alcohol for one-half hour. These solutions were decanted from the small insoluble residue. This residue in each case was dissolved in 10 c.c. of hot benzol and each added to the alcohol solutions. These were then titrated with a 0.191 normal, that is approximately one-fifth normal soda solution, with the following results:

No. 1 required 46.35 c. c. of the soda solution.
No. 2 required 1.05 c. c. of the soda solution.
No. 3 required 42.45 c. c. of the soda solution.
No. 1 and 2 together required 47.40 of the soda solution.

Deducting No. 3 from No. 1 and No. 2 we obtain 5.05 c. c. of soda solution corresponding to .434 gramms of myricyl alcohol, or 41.3 per cent. of myricyl alcohol in the carnauba wax used in sample No. 3.

This experiment shows that when the metallic soap and carnauba wax were mixed together there was a disappearance of stearic acid which combined with myricyl alcohol to produce the compound ester as stated in the patent; and the amount of stearic acid so found to have disappeared would correspond to 41.3 of myricyl alcohol.

*Q.* 15. Lewkowitsch and the other investigators of carnauba wax, as well as the text writers seem to be united in the statement that the acetyl value of carnauba wax is 55.24. From this acetyl value can you determine what the percentage of free myricyl alcohol in carnauba wax is?

*A.* Yes, it amounts to 43.3 per cent. This is assuming that the only free alcohol is myricyl alcohol; there are other free alcohols in carnauba wax so that this percentage would be modified to a slight extent. Of courst it must also be understood that individual samples might vary more or less as is always the case with crude organic products.

*Q.* 16. From Dr. Sturcke's paper on carnauba wax is there sufficient data given from which you can calculate the amount of free myricyl or other alcohol as determined by him?

*A.* Yes, the amount being about 48%.

*Q.* 17. It appears that in experiment No. 1 made by you the percentage of myricyl alcohol in the carnauba wax was in the neighborhood of 21% and that in experiment No. 2 the percentage was in the neighborhood of 41%; how do you explain the difference in these results?

*A.* The difference noted is in accordance with the well known law of mass action which governs the formation of esters. In this instance this law would require that the proportion of myricyl alcohol combining with the acid would increase as the excess of stearic acid increased; so that in experiment No. 2, where the excess of staric acid is very large the proportion of myricyl alcohol entering into the reaction would be very much larger in this case.

Experiment No. 1 was designed to determine the presence of myricyl alcohol in considerable amounts, and to determine whether there was an ester reaction, and Experiment No. 2 was designed particularly to determine the proportion of myricyl alcohol. I think I have already stated this in connection with experiment No. 1.

*Q.* 18. With the preferred formula of the patent in suit it appears that the amount of carnauba wax used is considerably smaller than the proportion adopteed by you in experiment No. 1. Would this fact in any way alter the result obtained in experiment No. 1, or, in other words, if in that experiment you had used the same relative proportions of carnauba wax and stearic acid that are set forth in the patent would the same substantial results have been reached?

*A.* If the exact proportions of the patent had been used the ester would not only have been more quickly formed, but the proportion of myricyl alcohol entereing the reaction would have been larger.

This experiment No. 1 as I have already stated, was designed solely for the purpose of determining the ester reaction and was not designed to produce the maximum amount of ester. As a matter of fact the result was not as favorable so far as obtaining an estimate of the quantitive amount of myricyl alcohol, as it would have been if the proportions of the patent had been observed. Since it was the object of this experiment No. 1 to determine the ester reaction, the maximum effect with the minimum quantity of material, was produced by using only a slight excess of free stearic acid.

*Q.* 19. I would like to have your opinion on another matter. Assuming a very complex organic material like the metallic soap composition we are here dealing with, would you consider it obvious that carnauba wax would be miscible or soluble in such a soap composition without making experiments to determine that fact?

*A.* Without having experimented relative to its solubility I would say not.

*Q.* 20. Would the fact that carnauba wax had previously been mixed with ozocerite lead you to suppose that carnauba wax would be miscible with the metallic soap composition.

*A.* As ozocerite and metallic soap are entirely different in their constitutions, it would naturally follow that it would not. It is practically impossible to reason that because a certain result is present with one material it would follow in another. For instance as a very simple illustration, alcohol and water are miscible and alcohol and ether are miscible; it might be supposed therefore that water and ether would be miscible when as a matter of fact they are not miscible.

> Counsel for complainant offers to counsel for defendant, for purposes of cross-examination, a translation of the article by Dr. H. Sturcke and referred to by Prof. Stillman, as well as the original article in German; the several text books referred to by the witness and the notes of the witness as kept under his direction during the experiments referred to.

Adjourned until Saturday March 16, 1907, at 10:30 o'clock A. M. at the office of Prof. Stillman, at Stevens Institute Hoboken, N. J.

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STEVENS INSTITUTE, HOBOKEN, N. J.
SATURDAY, March 16, 1907.

Met pursuant to adjournment.

Counsel present as before.

Counsel for complainant offers in evidence certified copy of the File Wrapper of the Aylsworth patent in suit and the same is marked "Complainant's Exhibit File Wrapper, Patent in suit.

THOMAS B. STILLMAN resumes the stand.

CROSS-EXAMINATION, by Mr. MASSIE:

*xQ*. 21. Referring to your experiment No. 1 please name the ingredients or separate compounds that were present in experiment No. 1. *A*. It was the soap composition.

*xQ*. 22. Please name and define the compounds that were present in that soap composition as you call it.

*A*. Stearate of soda, stearate af alumina and free stearic acid, and palmitic acid, possibly a small amount of palmitates and oleates of soda and aluminum.

*xQ*. 23. Is that all?

*A*. That is practically the composition, yes, sir.

*xQ*. 24. You have not added any ceresin or other hydrate carbon in forming what you designate a soap composition?

*A*. There is nothing else in there.

*xQ*. 25. For what purpose did you obtain the ceresin named towards the close of the first paragraph of your answer to *Q*. 14?

*A.* That was purchased to make other experiments which we did not consider it necessary to make.

*xQ.* 26. You have named six or possibly eight bodies present in what you call a soap composition; which of these bodies are of an acid nature, if any; which are of an alkaline nature, if any, and which are neutral and please state the amount of acidity and of alkalinity of each of the first two classes inquired of.

*A.* The acids are stearic, palmitic and a small amount possibly of oleic acid and the stearate of alumina is slightly acid; stearate of soda is alkaline; the palmitate of soda is also alkaline.

*xQ.* 27. That seems to add two more ingredients; the next part of the question is what is the amount of acid—of the acids enumerated by you in the proper proportions in which the same are present in your soap composition in Flask No. 1.

*A.* That was not determined.

*xQ.* 28. Nor did you determine the amount of alkalinity of the alkaline bodies in that composition? *A.* No, sir.

*xQ.* 29. Is it a fact in chemistry that a given substance may possess the properties of an acid with respect to a given substance and the properties of an alkali with respect to another substance?

*A.* It is so, yes, sir.

*xQ.* 30. Is that true of any of the bodies that you have named as being present in your soap composition?

*A.* I think aluminum is classed in that position.

*xQ.* 31. I meant to ask, was any of the bodies which is found in your flask No. 1 of that dual nature? I do not understand that aluminum as such is there present, but only the compounds of aluminum. *A.* Yes.

*xQ.* 32. Is there any body present in the soap composition which would be an acid with regard to some substance and alkaline with regard to others?

*A.* There is an excess of stearic acid, which is faintly acid, there is also sodium carbonate which acts alkaline.

*xQ.* 33. Is there any sodium carbonate present as such in the soap composition that you put into Flask No. 1 in your first experiment? *A.* There is not, no, sir.

*xQ.* 34. What I am trying to find out is this,—is there present in your soap composition any definite compound (I do not mean any element which has already entered into a compound) which has the property referred to of being acid in some relations and alkaline in other relations.

*A.* I have not tested this compound to determine that.

*xQ.* 35. You have named as present in your soap composition

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the following bodies, namely, stearic acid, palmitic acid, oleic acid, stearate of alumina, stearate of soda, palmitate of soda, palmitate of aluminum, oleate of soda and oleate of aluminum, although you indicate that some of these bodies may not be present or may be present in only small quantities. My question now is, is it a fact that you cannot tell from your knowledge of chemistry and from special examination whether or not any one of the bodies which I have just mentioned possesses the property of being acid in some relations and alkaline in other relations?

*A.* It would require analysis.

*xQ.* 36. I understand that according to your views the purified carnauba wax in your flask No. 2 consisted of myricyl cerotate and free myricyl alcohol and perhaps some other alcohols, and possibly one or two other bodies in faint traces; is that substantially correct? *A.* That is correct, yes, sir.

*xQ.* 37. What is myricyl cerotate, that is, can you describe its physical properties, its color, consistency, etc.?

*A.* Myricyl cerotate is a wax like body which is the principal constituent of carnauba wax; it clarifies to a white wax-like substance and its reactions are largely similar to that of carnauba wax itself of which it is a large component.

*xQ.* 38. Is myricyl cerotate found elsewhere than in carnauba wax? *A.* Yes; for instance, in bees wax.

*xQ.* 39. Did your experiments show conclusively and exclusively that there was no reaction whatever in Flask No. 3 except and solely for the reaction between the free myricyl alcohol and the free stearic acid. I will add to the question by stating that under "Myricyl alcohol" you may include any other free alcohol in the carnauba wax and under the name "free stearic acid" you may include the palmitic and oleic acid.

*A.* The test in Flask No. 3 in experiment No. 1 was designed to show that the reaction does take place between the stearic acid and the free myricyl alcohol to form water; that water is developed to form an ester. Other reactions can possibly take place in minute amount.

*xQ.* 41. I meant the question to apply to both of your experiments and I understand, of course, your testimony to be that in each of your two experiments the reactions between the alcohol and the stearic acid did take place; what I now ask is, do your two experiments both together exclude the possibility or probability that some other reaction may have taken place as between other bodies?

*A.* Taking these two experiments, No. 1 and No. 2, the results show that any other formation that takes place must be very diminutive in amount if at all.

*xQ*. 42. What is an ester?

*A*. An ester is a combination of an organic acid with an alcohol.

*xQ*. 43. The Aylsworth patent in suit speaks of a compound wax-like ether and of a wax like compound ether; do you by these terms understand the patentee to indicate what chemists call "esters"? *A*. I do, yes sir.

*xQ*. 44. Is myricyl cerotate an ester, that is, is it a combination of an organic acid with an alcohol? *A*. It is.

*xQ*. 45. With respect to the specific ester, myricyl cerotate, can this body be broken up by heat alone?

*A*. It has not been broken up by heat alone at any of the temperatures at which we have experimented.

*xQ*. 46. So far as you know, can this body, myricyl cerotate, be broken up by heat in the presence of some other body or bodies?

*A*. Our experiments have shown that it does not break up by heating.

*xQ*. 47. How did your experiments show that the myricyl cerotate was not broken up under the treatments to which you subjected the substances you were examining in connection with this suit?

*A*. The determination of the amount of myricyl alcohol used up would show that the ester remained undecomposed because in titrating with a very dilute solution of caustic soda the ester was not attacked, but only the free acids.

*xQ*. 48. Did any of the free myricyl alcohol unite with the stearate of aluminum, which I understand was slightly acid.

*A*. The stearate of aluminum was present in exceedingly small amounts; the action that takes place there is that the myricyl alcohol unites with the stearic acid and forms an ester.

*xQ*. 49. Does all of the aluminum put into the composition in order to produce the substance you call the soap composition, enter into the stearate of alumina, or only a part of the aluminum.

*A*. The aluminum is dissolved by the soda and forms aluminate of soda; all of the aluminum is combined with the soda. If there is any aluminate of soda in the stearate of alumina it is a very small amount.

*xQ*. 50. Then aluminate of soda is another body present in your soap composition?

*A*. That aluminate of soda when formed, is converted into soap and does not exist as aluminate of soda by itself.

*xQ*. 51. I understand that in making your socalled soap composition you first dissolved aluminum in the soda lye and thereby you had aluminate of soda, and that subsequently when this lye was added to the stearic acid, the aluminate of soda was transformed into something else and ceased to exist as aluminate of soda, is that correct? *A*. I did not say so.

*A*. I did not say so.

*xQ*. 52. Please state what bodies are present in your soap composition containing aluminum, what has become of the aluminum that was originally put into the mixture.

*A*. The aluminum, as stated before, is taken up by the soda to form aluminate of soda.

*xQ*. 53. But you just now said that it did not exist as aluminate of soda in the soap composition.

*A*. By itself; it forms a soap composition with stearic acid.

*xQ*. 54. Is that soap composition a definite chemical compound and has it a definite chemical name and a formula?

*A*. I have never analyzed it, so I cannot give you the chemical formula for it.

*xQ*. 55. What is the chemical name for that body?

*A*. It is a mixture of compounds and has no chemical name.

*xQ*. 56. It is a mixture; by that you mean it is not a definite chemical body?

*A*. It is a mixture of aluminate of soda and stearic acid, forming a soap.

*xQ*. 57. Then aluminate of soda is present in your socalled soap composition, but it is present mixed up *intimately* with the stearic acid in forming the soap.

*A*. It forms a soap with the stearic acid. That is to say, the stearic acid combines to form stearate, but if you allow fifty per cent. of the stearic acid to be palmitic acid, there will be palmitate of aluminum. When I speak of stearic acid, I mean the commercial product which generally contains, as I stated in a previous answer, about forty eight or fifty per cent of palmitic acid.

*xQ*. 58. Will you then explain briefly, so that a layman can understand it, what is meant by "titration" as employed by you in experiment No. 2?

*A*. Of course I could refer you to any number of text books which would cover this question and a neophyte in chemistry with a few months experience could explain the term. It is simply that a certain amount of acid is introduced into a certain amount of alkali, until a neutral point is reached, and one is saturated by the other. For instance, suppose you have a certain solution containing caustic soda, I would take a solution of standard acid and run it into that caustic soda solution until I found that the acid solution had neutralized the soda solution, by an indicator such as a litmus solution whereby the blue color of the litmus imparted to the soda solution is neutralized by the acid run into that solution; then, knowing the strength of the acid solution, we can calculate the percentage of soda in the soda solution; or vice versa, if you have an acid solution its acidity may be determined by a standard alkaline solution.

*xQ*. 59. Please refer to the latter part of your answer to *Q*. 14, dealing with the second experiment, the paragraph beginning "Deducting No. 3 from No. 1 and No. 2" etc.; is this the method by which you were there figuring, namely, the mixture in No. 3 requires 5.05 c. c. less of the soda solution indicating the presence in that mixture of a correspondingly smaller amount of the acid than is present in No. 1 and No. 2 added together, that you take the number of parts of free stearic acid that would combine with 5.05 c. c. of the soda solution, which for convenience I will call *x* parts of stearic acid, and that assuming the stearic acid is combined with the free (myricyl) alcohol, you know how many parts of myricyl alcohol would combine with a given number of parts of free stearic acid; and from the data you figure that .434 gramms of myricyl alcohol would combine with the quantity of stearic acid which I have called *x*; is this the way you figure out on that point? *A*. Yes.

*xQ*. 60. In the answer in noting the amount of moisture finally obtained from the three flasks in experiment No. 1, you say "1 gramm of water corresponds to 25.02 gramms of myricyl alcohol" etc. Please explain exactly what this means?

*A*. This means that by taking the molecular weight of the water we calculate it into the myricyl alcohol, which 1 gramm of water represents.

*xQ*. 61. That is, if we assume a reaction in which myricyl alcohol combines with stearic acid to form the ester, and if we know the amount of the alcohol and the acid we will know the amount of water produced as a sort of by-product. So that, contrary-wise, if we can ascertain the amount of water produced we can figure back and tell how much alcohol had entered into the combination with the acid. *A*. Quite true.

*xQ*. 62. Within what range of percentage did you say that free myricyl alcohol exists in carnauba wax after the same has been purified by washing and the other treatment described by you preliminary to our tests?

*A.* This has already been given in my testimony and the researches of Sturcke and Masyklene show those results, which are readily referred to. The experiments which I have made and testified to, show that in experiment No. 1 there was about 21% of myricyl alcohol and in experiment No. 2 which was much more accurate, there was about 41% of free myricyl alcohol.

*xQ.* 63. Assuming for the purpose of the present discussion that there is, say 40% of free myricyl alcohol; please state what quantity of free myricyl alcohol is in the formula of the Aylsworth patent in suit?

*A.* With the preferred example of the inventor as stated in the patent and the preferred proportions mentioned therein there would be somewhat over eight pounds of free myricyl alcohol on the assumption stated by you.

*xQ.* 64. How many pounds of free stearic acid will this quantity of free myricyl alcohol combine with?

*A.* That is determined by the working out of the molecular formulæ, the result being a little over five pounds of stearic acid, that is to say commercial stearic acid which contains about 50% of palmitic acid.

*xQ.* 65. Under the continuing assumption of the commercial purity of the carnauba wax, what percentage of fatty acids is there in the carnauba wax?

*A.* The literature would explain that.

*xQ.* 66. Can you without too much trouble give us the figure from the literature?

*A.* Without referring to the literature specifically I should say from one to three per cent. principally in the form of cerotic acid. I presume that where you refer to fatty acids you mean free fatty acids.

*xQ.* 67. Then the balance of canuba wax, about 60% is formed of esters composed of acids in combination with alcohols, is that correct? *A.* That is correct.

*xQ.* 68. Are these esters acid or alkaline or neutral with regard to the substance which you used in your titrating?

*A.* These esters are neutral to the effect of a one-fifth normal soda solution and are not decomposed by the same.

*xQ.* 69. In titrating the contents of flask No. 2 in experiment No. 2 you say there was required 1.05 c.c. of the soda solution; this soda solution combined with what body or bodies in the carnauba wax?

*A.* The soda solution being alkaline, of course combined with any free acid present in the wax, presumably the cerotic acid.

*xQ.* 70. Presumably it did not combine to any extent with any of the free myricyl or other alcohols and did not combine to any extent with any of the myricyl cerotate, is that correct?

*A.* That is correct.

*xQ.* 71. Assuming the free cerotic acid to be 2% (you have said it was from one to three); that the free (Myricyl) alcohol is forty per cent. (to give round numbers, where you named forty-one per cent.) and that the balance or fifty-eight per cent. is myricyl cerotate; how much total acid is there altogether either free or in combination with myricyl alcohol.

*A.* Assuming 40% of free myricyl alcohol, 58% of the ester and 2% of free cerotic acid, the composition of the wax would be 31.6 combined alcohol, 27.6 combined acid, 2 of free acid, and 40 of free alcohol, making a total of 101.2%.

*xQ.* 72. What are the combining weights of myricyl alcohol and cerotic acid?

*A.* The combining weight of myricyl alcohol is 454.5, of cerotic acid it is 396.4.

*xQ.* 73. Assuming the correctness of the figures given in your answer before the last, can you explain why some of the acids fail to enter in the combination, and some of the alkali in like manner is left out of the combination with the remaining percentage of the free acid.

*A.* Please state in your question the percentages of the reactions required.

*xQ.* 74. According to the figures given in the answer referred to, if I have taken them down correctly, there are 29.6 parts of the acid and there are 71.6 parts of the alcohol; it further appears that the cerotic acid and the myricyl alcohol are susceptible of combining together. What I want to know is, why does not all of the acid combine with the proper amount of alcohol instead of only 27.6 parts out of a total of 33.16?

*A.* As I did not make carnauba wax I cannot answer.

*xQ.* 75. It would seem to be the case that although the combining weights of cerotic acid and of myricyl alcohol are the figures given by you a few answers ago, yet that statement must be taken with the general qualification that all of the acids will not enter into combination even though there be an excess of the alcohol present, but that some portion of the acids would remain uncombined?

*A.* You are well aware of the constitution of carnauba wax

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are you not, and that carnauba wax carries a small amount of free cerotic acid and a large amount of myricyl alcohol and the ester of carnauba wax, and I think that answers your question.

*xQ*. 76. Defendant's counsel personally has no knowledge of carnauba wax, but his information is not that which is attributed in the answer of the witness. I understand your answer to mean that you agree with the proposition, namely that although we can attribute to cerotic acid and myricyl alcohol respectively their theoretical combining weight, yet it must be with the qualification that all of the acid and all of the alcohol do not combine even if there be sufficient quantities present but there remains a portion of free alcohol and free acid left over in the actual wax, uncombined? *A*. That is right.

*xQ*. 77. Assuming this last statement to be correct then would it not seem to follow that we cannot safely and accurately determine by calculation the total amount of either the cerotic acid or the myricyl alcohol in a given substance from knowing something about one an the other of the two bodies.

*A*. You must understand, in the tests I made in experiment No. 1, that the reactions taking place are eliminated when you subtract the amount determined there in carnauba wax and in the soap mixture, against the mixtture which we used in No. 3.

*xQ*. 78. Can we understand that you employed the same carnauba wax throughout your experiments, that is after you had purified by boiling, etc.? *A*. Yes.

*xQ*. 79. Did you determine the "acid value" of this particular substance after you had purified it, and if so what was its acid value? *A*. It was not determined.

*xQ*. 80. Did you determine its saponification value and if so what is the figure?

*A*. You must understand in the first place that this test was one to show whether the reactions take place as indicated in the patent, and to eliminate all sources of error we used the articles separately, and then combined, and heated them as stated in my testimony, so that the combinations might take place in them; before they were united, under the same conditions, we eliminated all sources of error in regard to what combinations took place and the results show that what took place in that mixture was according to the patent. Any hypothetical question which arises on this subject in regard to reactions in the carnauba wax or in the soap mixture, is entirely eliminated under the conditions under which the experiments were made and any extraneous matter outside of that is irrelevant to the question.

*xQ.* 81. So that you did not determine the saponification value of the carnauba wax which you used?

*A.* Not at all, it was not necessary.

*xQ.* 82. Please tell us exactly how you got the following figures found near the close of your answer to *Q.* 14, namely:

"No. 2. Required 1.05 c.c. of the soda solution."

*A.* That was obtained by titration.

*xQ.* 83. Does this tell us anything as to the acid value of the carnauba wax which you titrated?

*A.* The titration of the soda solution to that amount represents saturation by an acid.

*xQ.* 84. Do the figures just quoted, namely that 1.05 gramms of carnauba wax, required 1.05 c.c. of soda solution, give any indication of the saponification value of that carnauba wax?

*A.* It gives an indication of the saponification of the free acid.

*xQ.* 85. Some answers back you gave the figures for the amount of acid and alcohol in the carnauba wax upon our assumption as to the constituents of the latter, namely, as follows:

| | |
|---|---|
| alcohol in combination, | 31.6 |
| alcohol free, | 40. |
| acid in combination, | 27.6 |
| acid free, | 2. |

Is it possible for a chemist from these figures to calculate the saponification value of the carnauba wax and if so can you give us the result of that calculation by the next session? *A.* Yes.

*xQ.* 86. And the same question and request as to the acid value of carnauba wax? *A.* Yes.

*xQ.* 87. Will you please state on the record the meaning of "acid value" and of "saponification value"?

*A.* Acid value is the number of miligrams of K.O.H. required to saponify one gramm of the wax.

Saponification value is the number of miligrams of K.O.H. required to saponify one gramm of an oil or a wax.

*xQ.* 38. Will you please at your convenience and before the next session compare the figures given by you in this examination, relating to carnauba wax, with those given by Lewkowitsch on page 873 of the second volume of his work which I now show you and state whether your figures correspond with his?

*A.* It is not necessary, but I will do so.

*xQ.* 89. Did you isolate the myricyl alcohol in any of your experiments made in connection with this case?

*A.* No, sir, not as myricyl alcohol, but I did determine the amount of moisture due to the decomposition taking place by which an ester was formed and from the amount of water determined thereby, I calculated the amount of myricyl alcohol and acid used up to form the ester, under the conditions specified in the patent.

*xQ*. 90. What if anything can you say with regard to the properties of myricyl cerotate for the purpose of making molded sound records.

> Objected to as immaterial, irrelevant and having no basis in the direct examination. The witness is called purely as a chemical expert to testify regarding chemical reactions and not as an expert versed in the art of molding sound records.

*A*. I qualified as a chemist and not as a phonographic expert and know nothing whatever about phonographs.

> In view of the objection and of the answer just given, defendant's counsel objects to direct question 19 and the answer thereto as incompetent and notices a motion to strike the same out.
>
> The same objection and notice are given as to question 20 and the answer thereto.

*xQ*. 91. Assuming that the literature had stated that there was a substantial amount of free myricyl alcohol in carnauba wax, would it be known to the chemist that the alcohol in the carnauba wax could be caused to combine with free stearic acid?

*A*. It would be a matter of investigation.

*xQ*. 92. Are we to understand from this that if a chemist were told that carnauba was contains from 30 to 40% of free myricyl alcohol, he would not know without investigation whether he could produce an ester of that alcohol with free stearic acid?

*A*. It would require investigation.

*xQ*. 93. It would seem that the experiments and deductions testified to by you amount to reasoning in a circle; for instance, we are to assume that esters have been produced because such and such results had been observed by you in the treatments described, and then again, those results are accounted for as being due to the presumption that esters were produced, so that finally we conclude that inasmuch as esters were produced there must have been free myricyl alcohol present. If I am mistaken in this view of it I wish you would correct my statements.

*A*. The production of water under the conditions described in the experiment, shows combination of stearic acid with myricyl alcohol and that the myricyl alcohol has not been taken from the ester but is the free myricyl alcohol; this is confirmed by the titration in experiment No. 2 which shows that the amount of stearic acid used up in forming the ester corresponds to the formation of the ester required.

*xQ.* 94. Have you observed in Hefter's work referred to in your direct examination any statetments as to the amount of myricyl alcohol in carnauba wax?

*A.* That book states "Myricyl alcohol exists as palmitate in bees wax and further occurs in carnauba wax."

*xQ.* 95. In your direct deposition you note that Lewkowitsch gives the "acetyl value" of carnauba wax; what does "acetyl value" mean?

*A.* The description of acetyl value is somewhat lengthty but I will give it. For instance, we will treat wax or oil with acetic acid anhydride; we heat for two hours, then we wash the product with water and separate out all the acetic acid from the compound. This compound is saponified with a measured quantity of standard potash solution, of which we use an excessive quantity, and then the excessive potash over and above that required, to titrate the material, is titrated together with the standard acid solution, with a normal acid.

In other words, the acetyl value is the number of miligrams of K. O. H. required to saponify the acetic ester formed from one gram of substance.

This is fully explained in "Analysis of oils and allied substances" by A. C. Wright, at page 82, which I have referred to in my direct examination.

*xQ.* 96. What factors determine whether or not a given wax or oil shall have a high or low acetyl value?

*A.* It depends on the amount of free alcohol.

*xQ.* 97. Then is it a law absolute and invariable that the greater the amount of free alcohol in such substances, the greater its acetyl value, and is there a definite ratio between the percentage of free alcohol of such substance and its acetyl value?

*A.* Yes.

*xQ.* 98. Will any kind of alcohol determine in this manner the acetyl value of the substance regardless of the nature of that alcohol?

*A.* Search the literature; there are many alcohols with which I am not acquainted.

*xQ.* 99. So far as your own knowledge is concerned, either from literature or from your own investigations, will any alcohol in a wax or oil, provided the alcohol be "Free," determine the acetyl value of that wax or oil? *A.* Generally speaking, yes.

*xQ.* 100. Is it not a fact that in order for the free alcohol in a wax or oil to affect its actyl value, that alcohol must have certain radicals present, or in other words it must be certain forms of alcohol, and not any alcohol? *A.* Yes.

*xQ.* 101. Are you positive that there is no other factor whatever in causing the acetyl value, except the alcohol?

*A.* I have already explained what the actyl value is and how obtained, and in a complex substance like carnauba wax, it is possible that there may be traces of alcohol there that might affect the acetyl value where we calculate it into one constituent; but as far as I know the element determining the acetyl value is always the alcohol.

*xQ.* 102. Are you aware of the fact that there are some oils or waxes containing an acid element in which the variations in the amount of that acid element result in corresponding variations in the acetyl value of such wax or oil?

*A.* If you refer to carnauba wax I have not determined that.

Adjourned until Monday March 18, 1907 at Prof. Stillman's Laboratory Stevens Institute, Hoboken, N. J. at 1030 A M.

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STEVENS INSTITUTE, HOBOKEN, N. J.
Monday, March 18, 1907.

Met pursuant to adjournment.

Counsel present as before.

The CROSS-EXAMINATION of PROF. STILLMAN was continued by Mr. MASSIE.

Professor Stillman—Before taking up the data called for in *xQs.* 85, 86 and 88 I wish to say that as far as concerns the soap composition used in my experiments and to which the carnauba wax was added with the results indicated, that soap composition is an extremely complex organic compound containing stearic, palmitic and oleic acids, stearates, palmitates and oleates of soda, and small amounts of stearates, palmitates and oleates of alumina. It is a compound which I have never encountered before, an artificial material used in the special art and I have neveer experimented with the same individually, but only, as stated, when combined with carnauba wax. Whatever I have said or may say regarding this soap composition, its makeup, and the reactions which occur in its manufacture, is based, not on actual experiments, but on theoretical considerations alone. What I have done in this case and what I tesetify to of my own knowledge is in reference to the specific experiments referred to. My first inquiry was this, having a known composition containing free stearic (and palmitic) acid and adding to the same a wax known to contain myricyl alcohol, would the evolution of water, under the precautions observed, indicate an ester reaction. I believe that it does. My second inquiry then was, assuming that there is an ester reaction would the loss of a determined amount of stearic acid, under the precautions observed, correctly indicate the extent of the ester reaction from which the amount of the myricyl alcohol, assuming it to be such, can be calculated. In my opinion this question should also be answered affirmatively, the proportion being substantially 41%.

Referring now specifically to *xQ*. 85 and assuming such a mixture as is there referred to, its saponification value would be 39.4.

Regarding *xQ*. 86 and on the same assumption, the acid value would be 2.8.

In reference to the matter called for in *xQ*. 88 I find that from the results obtained in connection with flask No. 2 in experiment No. 2 the acid value determined would be 10.7. In the book by Lewkowitsch the acid value of carnauba wax varies from 2 to 7, but I consider this a sufficiently close agreement in view of the fact that the experiment made by me was not for the purpose of determining the acid value, and only a very small amount of wax was used and was subjected to totally different conditions than it would have been if the acid value was alone to be deteremined.

Regarding the saponification value I have had the same calculated on the basis of the assumed composition set forth in *xQ*. 85 and find that its saponification value is 39.4, as already given. With Lewkowitsch its value is about 80.

*xQ*. 103. Before you made your second experiment in which you titrated carnauba wax in flask No. 2, you carried out certain operations in purifying the carnauba. What effect, if any, did these preliminary operations have in the percentages of the free acid, the free alcohol, the combined acid and the combined alcohol respectively.

*A*. The purification was simply to remove any extraneous matters which might be in the impure wax purchased ,in the market.

*xQ*. 104. In the titrating you found 1.05 c. c. of the particular soda solution employed requisite to titrate 1.05 gramms of the carnauba; will you from this data calculate the percentage of free acid in the carnauba? *A*. 7.6%.

*xQ*. 105. How does this compare with Sturcke's report as to the percentage of free acids in carnauba wax?

*A*. Sturcke makes no mention of the determination of free acids.

*xQ*. 106. Does Sturcke make any mention of the determination of the presence of free cerotic acid in carnauba wax, and if so, what?

*A*. Sturcke states that in his researches on carnauba wax he finds that free cerotic acid was absent. Other observers, however, claim it is present. The acid value obtained by us in titrating flask No. 2 showed the presence of free acid of some sort.

*xQ*. 107. Did you find by actual determination the percentage of total acid present in the carnauba wax, comprising both the free acids and the acids in combination?

*A*. I did not determine the total acids.

*xQ*. 108. Lewkowitsch gives the per cent. of acids as 47.95, and Sturcke, (by giving the per cent. of alcohol and hydro carbon as 55) gives the percentage of acids as 45; is that statement correct?

*A*. Sturcke made no quantitative determination in that experiment stated on page 290 of volume 222 of Leibig's Annalen, he using large portions of the material to obtain portions of the ingredients for experimental purposes. Sturcke does not state that 45 per cent. of acids is present in carnauba wax. You have correctly quoted the figure given by Lewkowitsch.

*xQ*. 109. And it is a fact, is it not, that in the same table Lewkowitsch makes a statement that Sturcke found 55 per cent. of alcohols and hydro carbon? *A*. That is correct.

*xQ*. 110. On the middle of page 8 of the typewritten translation of Sturcke's article, which complainant's counsel presented for the purpose of cross examination, I find this sentence, referring to the alcohols and hydro carbon:

> "The total extract quantity, from the total quantity of carnauba wax treated (altogether 2800 g.), amounted to about 1550 g."

Is it your understanding that this is the passage which Lewkowitsch had in mind in giving the figures in the table on page 873 of his work?

*A*. It is; but it must be borne in mind that this is not a quantitative determination; it represents an extract obtained; but does not claim to be a quantitative determination. At page 287 of the original article in German, he makes a quantitative determination to find out the solubility of carnauba wax in alcohol and finds 61 per cent. as soluble, whereas, where he deals with the large quantity of 1200 gramms for the further experiment he takes no special pains to get a complete solution for his further investigations. In treating 1200 grams. with alcohol only about 29% was dissolved, and it is this solution, or a solution similarly obtained which he used for his further work.

*xQ.* 111. I do not read German and so will have to refer to the translation produced by complainant's counsel. Beginning at the bottom of page 7 of the translation I find the following:

> "The wax was directly saponified, separated with salt, dried, and the soap extracted. The extraction was carried so far until a further extraction of ten hours yielded only a few miligrams. In the following are again noted down the numerical order, duration, melting point, and the approximate quantity of the separate fractions"
>
> (And then follows a table in which are two lines relating to the boiling point, etc)
>
> "The total extract quantity, from the total quantity of carnauba wax treated (altogether 2800 g.) amounted to about 1550 g."

Does this extract which I have called to your attention lead you to modify the answer you have just given? *A.* No, sir.

*xQ.* 112. What reason if any have you to doubt the correctness of the figure given by Lewkowitsch for the total percentage of acids namely, 47.5?

*A.* The figures given by Lewkowitsch are contradictory of Sturcke's work and of my own work; they also contradict other results obtained by Lewkowitsch himself.

*xQ.* 113. The work by Sturcke which you refer to as contradicting these figures is the work referred to by you in the previous answers this morning, is it? *A.* It is.

*xQ.* 114. And the work by yourself that contradicts his figures is the work which you have done in connection with this suit and concerning which you have testified on the direct examination? *A.* Yes.

*xQ.* 115. Where are the contradictions of these figures by Lewkowitsch himself?

*A.* Referring to his book at page 873 I find the statement of the fatty acids to be 47.95 per cent. and of the alcohols to be 55 per cent. These figures are not reconcilable.

*xQ.* 116. Merely because when added together they show 102.95 per cent. instead of an even 100 per cent.?

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*A.* Yes, and also because of the high acetyl value given by Lewkowitsch; this acetyl value is 55.24, which would correspond with 47.3 per cent. of free myricyl alcohol. In the second place it is deducible from Sturcke's article that the amount of alcohols determined by him was over 55 per cent. If therefore we add to this amount of alcohol the quantity of acid referred to by Lewkowitsch, namely 47.95, we do not get merely 102.95 per cent. but we get a figure probably as high as 115 or 120 per cent. In the third place, as an evidence of the unreliability of the saponification value as a basis of definite calculation as to the amount of ester, if we assume the figure given by Lewkowitsch, namely 80, for the saponification value, that would represent about 115 per cent. of the ester.

*xQ.* 117. On what basis do you say that the acetyl value found by Lewkowitsch, namely 55.24, would correspond with 47.3 per cent. of free alcohol?

*A.* Assuming the alcohol to be myricyl alcohol, that corresponds to 47.3 per cent. We calculate it, by comparing the value for carnauba wax, namely 55.24, with the value of 116.9, given by Lewkowitsch on page 271, for myricyl alcohol.

*xQ.* 118. Is it not a fact that the acetyl value of bodies of this nature depends, not alone on the alcohols present, but also upon the quantity of certain acids present?

*A.* Kindly define what you mean by "Certain acids present."

*xQ.* 119. Any one or more of the acids that may be present in oil, and fatty acids containing esters and alcohol?

*A.* The method used by Lewkowitsch in determining the acetyl value is such as to eliminate the disturbing effect due to the presence of acids.

*xQ.* 120. I have gathered that, with regard to the total quantity of acids present, our authorities are Sturcke, whose figures you construe as not being the maximum results of a quantitative analysis, Lewkowitsch, whose figures you question, and your own investigations in connection with this suit. Will you for the moment disregard your own recent investigations, and, confining yourself to the published authorities, tell what in your opinion is the correct figure for the total amount of acids in carnauba wax?

*A.* As far as I know Story-Maskylene made no determination of the amount of acids. Sturcke, as far as I know, makes no direct reference to the amount of acid, but it can be roughly estimated from his results at about 27 per cent., although it might vary from 20 to 35; the data is not sufficiently accurate to enable us to determine any closer than this. I find no reference in Wright's work to the amount of acids. Lewkowitsch, as I have previously stated gives the amount of acids as 47.95; but for the reasons already given, I doubt the accuracy of those figures. Aside from my own investigations, it is a fact, therefore, that the literature on the subject varies from about 20 to 50 per cent.

*xQ*. 121. With regard to your own investigations I understand that you did not directly determine the total amount of acids present, but determined the amount of free alcohol present and the amount of free acid present and upon these two factors you could then, by calculation, arrive at the total quantity of acid and alcohol present, and the amount of each present in combination?

*A*. I did determine the free acids and free alcohol, and if the nature of the acid be known, and the alcohol, then the amount in combination could be calculated, but I did not determine them directly.

*xQ*. 122. Assuming for the moment that Sturcke's figures are correct and the total acids present in the carnauba amount to 27 parts in 100, and further assuming that from 2 to 7 per cent. of free acid is present—call it, for convenience, 4.5 per cent. average of free acid—so that we would have 22.5 parts of the free acid in combination; how many parts of the alcohol, assuming it to be myricyl, would combine with these 22.5 parts?

*A*. There would be 26 per cent. of myricyl alcohol required to combine with 22.5 per cent. of cerotic acid. But it must be remembered that 22.5 per cent. is a very rough estimate of the combined acids.

*xQ*. 123. Now please assume that Lewkowitsch figures are correct and there are 47.95 per cent. of the total acid in the carnauba wax, and also assume as correct Lewkowitsch figures for the free acids, which we may deduce as being 1.5 which would leave 46.45 parts of combined acid in 100 parts of carnauba wax; how many parts of myricyl alcohol would combine with these 46.45 parts? *A*. 53.2.

*xQ*. 124. In experiment No. 1 after you had subjected the carnauba to a high temperature for a considerable time there still remained more or less water or moisture contained in the mechanical admixture, did there not? *A*. A small percentage, yes.

*xQ*. 125. And the same is true of the soap composition, namely, that although it had been subjected to a comparatively high temperature, away beyond the boiling point of water, there still remains some traces of moisture or water in the composition?

*A.* Quite true.

*xQ.* 126. It seems to be the fact then that carnauba wax and the soap composition and possibly similar bodies have this property of retaining small traces of water in mechanical admixture and it is therefore difficult to remove all of the water even at temperatures away beyond the boiling point of water. Can you briefly give some explanation of why this is or to what this is due?

*A.* In experiment No. 1 we showed that the moisture was eliminated and determined, absolutely, until there was no more water evolved from either one. We also determined that the moisture in the composition was very largely in excess of that produced by the two separately under similar conditions. It follows that by the calculation of the water formed in·the mixture, eradicating and eliminating the water in the other two, an ester was produced; as far as the experiments are concerned with the treatment of all the three samples under the same condition and at the same temperature the amount of moisture as found in the first two flasks was about 2/10 of 1 per cent. This is almost a negligible quantity and is likely to remain in a material when heated up to quite a high temperature. Furthermore, it is extremely difficult to drive off the last traces of water from any material containing it, especially oilly mixtures. This small percentage was deducted from the determination of water as given in No. 3.

*xQ.* 127. That is not quite the question I asked. Previous to experiment No. 1 the contents of the flask No. 1 had been heated to 450 degrees F. "until no further action was seen," and in like manner the contents of flask No. 2 had been previously heated to 450 degrees F. A layman would suppose that a temperature slightly above the boiling point of water, namely, 212 degrees F. would drive off all the water. To what property is it due that all the water is not driven off, or what is the explanation of this fact?

*A.* It is simply a matter of time and temperature, and it is well known that the last traces of water are often difficult to remove.

*xQ.* 128. Has the viscosity of the composition containing traces of water anything to do with the freedom or difficulty with which the last traces of water are liberated therefrom.

*A.* It has practically no effect under the conditions under which the experiments were conducted. At the comparatively high temperature employed all the liquids were thoroughly fluid and the stream of nitrogen gas passed through would make the elimination of water practically complete.

*xQ*. 130. The question was not as to the result of your experiments, but it was this,—has the viscosity of the material anything to do with the readiness with which the remaining traces of moisture can be obliterated?

*A*. It is one of the factors which determines the readiness with which moisture would be given off.

*xQ*. 131. What are the other factors that determine the readiness with which moisture is driven off from any composition?

*A*. The heat employed, the pressure upon the surface of the fluid, the time employed, and the chemical nature of the substance; also agitation or the bubbling of a gas through the liquid.

*xQ*. 132. Assuming that the same temperature is employed in each of two cases, the same atmospheric pressure, the same agitation or passing of gas through the mixture and the same duration of treatment, and the compositions are of the same or similar nature, then viscosity is the only factor in determining whether one or the other thereof has its moisture liberated with greater freedom is it not?

*A*. It is very difficult to assume that two materials would be the same or substantially the same and there be no difference in the viscosity, but upon your assumption I think you are correct.

*xQ*. 133. In carrying out the experiments to which you have testified what part did you take personally?

*A*. I exercised a general supervision over these experiments, saw what ingredients were put in and how the treatments were carried on. The actual work, however, of handling the material and the practical operations were performed by my assistant, Dr. Langmuir.

*xQ*. 134. If there be any error due to the personal equation the error is Dr. Langmuir's and not yours? *A*. Yes.

*xQ*. 135. If there be in your experiment No. 2 which is your quantitative experiment, an error of one milligram, what would this one milligram correspond to on the scale of the formula given in the patent in suit?

*A*. Assuming the conditions to be the same, then an error of one milligram in my experiment No. 2 would be equivalent to 1/10th of 1 per cent.

*xQ*. 136. To what extent did you observe the work done by Dr. Langmuir and to what extent did you verify his observations?

*A*. I carefully followed the experiments and observed the phenomena that developed, but as to verifying the actual figures and calculations of Dr. Langmuir I have accepted them as correct as I know he is very careful in this sort of work.

*xQ*. 137. Near the beginning of your description of experiment No. 3, you say the three test tubes were connected respectively with potash absorbent bulbs filled with alcohol; did those bulbs contain both alcohol and potash, or is this merely a description of the type of bulb?

*A*. It is a description of the type of bulb containing alcohol.

*xQ*. 138. Can you state whether or not beeswax contains free alcohol and, in fact, what are the constituent bodies in beeswax?

*A*. I refer to the literature and quote as follows:

Lewkowitsch, at page 884, quoting Brodie, and others, says:

> "Beeswax consists chiefly of a mixture of crude cerotic acid and myricyl palmitate. It also contains, in small quantities, free melissic acid, myricyl alcohol, uncombined ceryl alcohol and another alcohol of unknown composition."

*xQ*. 139. So far as you are aware does Chinese wax contain any free alcohol?

*A*. You must understand that my experiments were made entirely on carnauba wax and had no reference whatever to Chinese wax.

*xQ*. 140. If it should be established in this case that Chinese wax contains no free alcohol, then, if Chinese wax be added to the soap composition containing free stearic acid, under the treatment described in the patent in suit, would any ester be generated.

> Question objected to as immaterial and irrelevant and as having no basis in the direct examination, and counsel for defendant is warned that by questions of this sort he makes the witness his own.

*A*. There might be inter action between these matereials with the soap composition, but investigations would have to be made before any definite statement as to what took place could be given.

*xQ*. 141. Is it possible that in dealing with carnauba, (whether or not it contains free alcohol) and a soap composition containing free stearic acid, inner reactions may take place between the ingredients and the myricyl cerotate of the stearic acid? *A*. It is quite possible.

Cross examination closed.

RE-DIRECT EXAMINATION by Mr. Dyer:

*R-dQ*. 142. In answer to *xQ*. 55 you said that a certain compound had "No chemical name," what was your understanding of the compound there referred to?

*A.* Palmitate and stearate, to form soap with the alumina. These are stearates and palmitates of aluminum, but there is no definite chemical name for the two when combined together in this mixture.

Signature and certificate waived.

IRVING LANGMUIR, a witness produced on the part of the complainant having been first duly sworn according to law testified as follows:

DIRECT EXAMINATION, by Mr. DYER.

*Q.* 1. Please give your name, age, residence and occupation?

*A.* My name is Irving Langmuir, I reside at 24 West 38 St., New York city; I am 26 years of age and my occupation is Instructor in Engineering Chemistry at Stevens Institute, Hoboken N. J.

*Q.* 2. What was your chemical education?

*A.* I studied four years at Columbia University obtaining the degree of Metallurgical Engineer, then I studied three years at Goettingen, Germany, making a specialty of Chemistry and physical chemistry; I obtained there the degree of Ph.D.; for the last year I have been in Stevens Institute as Instructor of Engineering Chemistry and am still so employed.

*Q.* 3. Were you present during the taking of the testimony of Prof. Stillman in this case? *A.* I was.

*Q.* 4. Did you assist Prof. Stillman in the experiments to which he testified? *A.* Yes.

*Q.* 5. Did you make the calculations from the experiments which Prof. Stillman gave in his deposition. *A.* I did.

*Q.* 6. Are those calculations correct?

*A.* To the best of my knowledge they are.

*Q.* 7. Do you agree with Professor Stillman regarding the conclusions reached by him in his direct examination? *A.* Yes.

*Q.* 8. Do you regard the first experiment testified to by him as demonstrating conclusively and undeniably the formation of an ester? *A.* Yes.

*Q.* 9. Do you regard the second experiment testified to by him as indicating conclusively the extent of the ester reaction?

*A.* Yes.

*Q.* 10. And, knowing the amount of that ester reaction, would it be possible to determine the percentage of myricyl alcohol in carnauba wax? *A.* With a fair degree of accuracy, yes.

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CROSS-EXAMINATION, by Mr. MASSIE:

*xQ*. 11. Prior to February 28, 1907 had you made any investigations as to the nature of carnauba wax and its behavior in connection with other bodies in producing esters? *A*. No.

*xQ*. 12. The sum total of your investigations of carnauba wax is represented by the work done by you in preparation for this suit? *A*. Yes.

Signature and certificate waived.

## Inspectors' Report, Lot "B."

| | | | | |
|---|---|---|---|---|
| Selection 9298 | Serial 23 | ½ long | O. K. | Temp. 78 deg. |
| “ | “ | “ | Runs out | “ “ |
| “ | “ | “ | Out of round | “ “ |
| “ | “ | “ | “ | “ “ |
| “ | “ | ½ short | “ | “ “ |
| “ | “ | O. K. | O. K. | “ “ |
| “ | “ | long | “ | “ “ |
| “ | “ | ½ short | Runs out in beginning | “ 60 “ |
| “ | “ | ¾ long | O. K. | “ “ |
| “ | “ | ¼ short | Runs out | “ “ |
| “ | “ | ¼ short | Out of round | “ “ |
| “ | “ 24 | 1 short | Runs out | “ 78 “ |
| “ | “ | 1 “ | “ | “ “ |
| “ | “ | ¾ “ | “ | “ “ |
| “ | “ | ½ “ | Out of round | “ “ |
| “ | “ | ½ “ | “ | “ 60 |
| “ | “ | ½ “ | O. K. | “ 78 |
| “ | “ | ¾ “ | Runs out bad | “ 78 |
| “ | “ | ¾ “ | Out of round | “ “ |
| “ | “ | 1¾ “ | O. K. | “ “ |
| “ | “ | 1½ “ | Runs out | “ “ |
| “ | “ | 1 “ | Out of round | “ 65 |
| “ | “ | 1 “ | “ “ | “ “ |
| “ | “ | 1 “ | Runs out | “ 60 |
| “ | “ | 1 short | O. K. | “ 60 |
| “ | “ 25 | ½ short | Out of round | “ 78 |
| “ | “ | ½ “ | “ “ | “ “ |
| “ | “ | ½ short | Out of round | “ “ |
| “ | “ | | Cracked when received | |
| “ | “ | O. K. | Out of round | “ “ |
| “ | “ | ¾ long | Runs out | “ “ |
| “ | “ | ½ short | Out of round | “ “ |
| “ | “ | ½ long | Runs out | “ 65 |
| “ | “ | 1 short | “ “ | “ 60 |
| “ | “ | O. K. | Out of round | “ 60 |
| “ | “ | ¼ long | “ “ | “ 60 |
| “ | “ | “ | O. K. | “ 60 |
| 9328 | “ 3 | 1 short | Out of round | “ 78 |
| “ | “ | ½ “ | O. K. | “ “ |
| “ | “ | ½ “ | “ | “ 65 |
| “ | “ | 1 “ | Runs out | “ 78 |
| “ | “ | 1 “ | “ “ bad | “ “ |
| “ | “ | ½ “ | Runs out in beginning | “ “ |
| “ | “ | 1¼ “ | Runs out | “ “ |
| “ | “ | Blinds can't measure | | |
| “ | “ | “ | “ “ | |
| “ | “ | ½ long | Runs out | “ 60 |
| “ | “ | O. K. | O. K. | “ 60 |

| | | | | | |
|---|---|---|---|---|---|
| Selection 9328 | Serial | 6 | 1½ short | Out of round | Temp. 78 deg. |
| “ | “ | | 1½ “ | “ “ | “ 78 |
| “ | “ | | 1 “ | Runs out at end | “ 78 |
| “ | “ | | 1 “ | Out of round | “ 78 |
| “ | “ | | 1 “ | “ “ | “ 78 |
| “ | “ | | 1 “ | “ “ | “ 65 |
| “ | “ | | 1¼ “ | Runs out at end | “ 78 |
| “ | “ | | ¾ “ | O. K. | “ 78 |
| “ | “ | | ½ “ | Runs out bad | “ 78 |
| “ | “ | | ½ “ | “ “ “ | “ 60 |
| “ | “ | | O. K. | “ “ “ | “ 60 |
| “ | “ | | “ | “ “ “ | “ 65 |
| “ | “ | | 1 short | “ “ “ | “ 65 |
| “ | “ | 18 | 1½ “ | “ “ “ | “ 78 |
| “ | “ | | “ “ | “ “ “ | “ “ |
| “ | “ | | 1¾ “ | “ “ “ | “ “ |
| “ | “ | | 2½ “ | “ “ “ | “ “ |
| “ | “ | | 2½ “ | “ “ “ | “ “ |
| “ | “ | | 2 “ | Out of round | “ “ |
| “ | “ | | 1½ “ | Runs out | “ “ |
| “ | “ | | 1½ “ | Runs out | “ “ |
| “ | “ | | 2½ “ | “ | “ “ |
| “ | “ | | Cracked when received | | |
| “ | “ | | 1¼ short | Out of round | “ “ |

## Inspector's Report. Lot “C.”

| | | | | | |
|---|---|---|---|---|---|
| Selection 9328 | Serial | 3 | ¼ long | Runs out | Temp. 78 deg. |
| “ | “ | | ¾ long | “ “ | “ |
| “ | “ | | O. K. | “ “ | “ |
| “ | “ | | “ | Runs out at end | “ |
| “ | “ | | ½ long | Runs out | “ |
| “ | “ | | ¾ long | O. K. | “ |
| “ | “ | | ½ long | “ | “ |
| “ | “ | | ¾ short | Runs out | “ |
| “ | “ | | ¾ “ | “ “ | “ |
| “ | “ | 6 | 1 short | Runs out at end | “ |
| “ | “ | | ¾ “ | “ “ “ “ | “ |
| “ | “ | | ½ long | Runs out in beginning | “ |
| “ | “ | | O. K. | O. K. | “ |
| “ | “ | | ¼ short | Runs out at end | “ |
| “ | “ | 18 | 2 short | Runs out in beginning | “ |
| “ | “ | | 1 short | Runs out | “ |
| “ | “ | | ½ long | “ “ | “ |
| “ | “ | | ½ short | “ “ at end | “ |
| “ | “ | | ¾ short | “ “ | “ |
| 9298 | “ | 23 | O. K. | “ “ | “ |
| “ | “ | | ½ long | “ “ | “ |
| “ | “ | | ½ long | O. K. | “ |
| “ | “ | | 1 long | Runs out | “ |
| “ | “ | | ½ long | O. K. | “ |
| “ | “ | | 1 long | O. K. | “ |
| “ | “ | | ½ long | Runs out | “ |
| “ | “ | 24 | O. K. | O. K. | “ |
| “ | “ | 25 | O. K. | Runs out at end | “ |
| “ | “ | | O. K. | O. K. | “ |
| “ | “ | | O. K. | “ | “ |
| “ | “ | | O. K. | “ | “ |

## Inspector's Report. Lot "D."

Tempt. 65 Deg.

| | | | | | |
|---|---|---|---|---|---|
| Selection 9298 | Serial | 23 | ½ short | O. K. | (Temp. 74 deg.) |
| " | " | | ½ long | " | |
| " | " | | ¾ " | " | |
| " | " | | ¼ " | " | |
| " | " | | O. K. | " | (Temp. 74 deg.) |
| " | " | | 1 long | " | |
| " | " | | ¾ " | " | |
| " | " | | ¾ " | Runs out | |
| " | " | | ¾ " | O. K. | |
| " | " | 24 | 1 long | Runs out | (Temp. 74 deg.) |
| " | " | | ½ short | Out of round | (Temp. 74 deg.) |
| " | " | | O. K. | Runs out | |
| " | " | | ½ long | O. K. | |
| " | " | | O. K. | O. K. | |
| " | " | | O. K. | O. K. | |
| " | " | | O. K. | O. K. | |
| " | " | | ½ long | Runs out | |
| " | " | | O. K. | Runs out | |
| " | " | | O. K. | O. K. | |
| " | " | | O. K. | Out of round | |
| " | " | 25 | O. K. | O. K. | (Temp. 74 deg.) |
| " | " | | ½ short | O. K. | |
| " | " | | ¾ short | Out of round | |
| " | " | | ¾ long | Runs out | |
| " | " | | ½ " | Runs out | |
| " | " | | ¾ " | O. K. | |
| " | " | | ½ " | Runs out | |
| " | " | | ½ long | O. K. | |
| 9328 | " | 3 | 1½ short | O. K. | (Temp. 74 deg.) |
| " | " | | O. K. | O. K. | |
| " | " | | ½ short | O. K. | |
| " | " | | 1 short | O. K. | |
| " | " | | ½ long | O. K. | |
| " | " | | ½ long | Runs out | |
| " | " | | ¾ short | O. K. | |
| " | " | | ½ long | Runs out | |
| " | " | | ½ short | Runs out | |
| " | " | | O. K. | Runs out | |
| " | " | | 1 short | Runs out | |
| " | " | 6 | ½ short | " " | |
| " | " | | ½ long | " " | |
| " | " | | ½ short | " " | |
| " | " | | O. K. | " " | |
| " | " | | 1 short | O. K. | |
| " | " | | 1 short | Runs out | |
| " | " | | ½ short | " " | |
| " | " | | O. K. | " " | |
| " | " | | ½ short | " " | |
| " | " | | ½ long | " " | |
| " | " | | ¾ short | " " | |

65 Deg. Temp.

| | | | | | | |
|---|---|---|---|---|---|---|
| Selection | 9328 | Serial | 6 | 1 short | Runs out | |
| | " | " | 18 | ½ short | O. K. | (Temp. 74 deg.) |
| | " | " | | O. K. | Runs out | " " |
| | " | " | | ½ short | " " | " " |
| | " | " | | 2 short | Runs out | |
| | " | " | | 1½ " | O. K. | |
| | " | " | | 1 " | Runs out | |
| | " | " | | ¾ " | O. K. | |
| | " | " | | 2 " | Runs out | |
| | " | " | | O. K. | O. K. | |
| | " | " | | 1 short | Runs out | |
| | " | " | | ½ " | Out of round | |
| | " | " | | 1 " | Runs out | |
| | " | " | | 1 " | O. K. | |
| | 9298 | " | 25 | O. K. | O. K. | |

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## Inspector's Report. Lot "E."

Temp. 70 deg.

| | | | | | |
|---|---|---|---|---|---|
| Selection | 9298 | Serial | 23 | 1 long | O. K. |
| | 9298 | " | | 1½ " | Out of round |
| | " | " | | 1 " | O. K. |
| | " | " | | 2 " | Out of round |
| | " | " | | 1 " | O. K. |
| | " | " | | 1½ " | O. K. |
| | " | " | | 1 " | O. K. |
| | " | " | | 1¾ " | O. K. |
| | " | " | | 1½ " | Runs out |
| | " | " | | 1¼ " | O. K. |
| | " | " | | 1½ " | O. K. |
| | " | " | | 2 " | O. K. |
| | " | " | | 1½ " | Runs out |
| | " | " | | 2 " | O. K. |
| | " | " | 24 | O. K. | Runs out |
| | " | " | | ¾ long | O. K. |
| | " | " | | ½ " | Out of round |
| | " | " | | ¾ " | O. K. |
| | " | " | | ¾ " | O. K. |
| | " | " | | ¾ " | Out of round |
| | " | " | | ½ " | Out of round |
| | " | " | | 1 " | Runs out |
| | " | " | | ¾ " | Runs out |
| | " | " | | ½ " | O. K. |
| | " | " | | ½ " | O. K. |
| | " | " | | ½ short | Runs out |
| | " | " | | 1½ long | Runs out |
| | " | " | 25 | 1 long | O. K. |
| | " | " | | 1¼ long | O. K. |
| | " | " | | 1½ " | Runs out |
| | " | " | | 1 " | O. K. |
| | " | " | | ½ " | O. K. |
| | " | " | | 1 " | Out of round |
| | | " | | O. K. | Runs out |
| | " | " | | 1 long | O. K. |
| | 9328 | " | 3 | O. K. | O. K. |

| | | | | |
|---|---|---|---|---|
| Selection 9328 | Serial | 23 | 1½ long | Runs out |
| “ | “ | | 1 “ | O. K. |
| “ | “ | | ¾ “ | O. K. |
| “ | “ | | 1 “ | Runs out |
| “ | “ | | ½ “ | “ “ |
| “ | “ | | ½ “ | Out of round |
| “ | “ | | 1½ “ | Runs out |
| “ | “ | | ¾ “ | Runs out |
| “ | “ | | 1 “ | O. K. |
| “ | “ | 6 | ½ long | Out of round |
| “ | “ | | O. K. | Out of round |
| “ | “ | | ½ long | Runs out |
| “ | “ | | O. K. | “ “ |
| “ | “ | | ½ long | “ “ |
| “ | “ | | O. K. | “ “ |

Temp. 70 deg.

| | | | | |
|---|---|---|---|---|
| Selection 9328 | Serial | 6 | ½ long | Runs out |
| “ | “ | | 1 “ | “ “ |
| “ | “ | | ½ “ | “ “ |
| “ | “ | | 1 “ | Out of round |
| “ | “ | | ½ “ | O. K. |
| “ | “ | | 1 “ | Runs out |
| “ | “ | 18 | ½ short | Out of round |
| “ | “ | | ½ long | O. K. |
| “ | “ | | O. K. | Runs out |
| “ | “ | | O. K. | Runs out |
| “ | “ | | ½ long | “ “ |
| “ | “ | | O. K. | O. K. |
| “ | “ | | ½ long | Runs out |
| “ | “ | | ½ short | “ “ |
| “ | “ | | ½ short | “ “ |
| “ | “ | | ½ long | O. K. |
| “ | “ | | ½ long | Runs out |

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## File Wrapper and Contents Patents in Suit.

$ *15* Received ½
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3 *sza*
*ck* 1903
Chief Clerk, U. S. Patent Office.

PETITION.

*To the Commissioner of Patents:*

Your petitioner, JONAS W. AYLSWORTH, a citizen of the United States, residing at East Orange, in the County of Essex and State of New Jersey, whose post-office address is No. 223 Midland Avenue, East Orange, New Jersey, prays that letters patent may be granted to him for the COMPOSITION FOR MAKING DUPLICATE PHONOGRAPH RECORDS set forth in the annexed specification; and he hereby appoints Frank L. Dyer (Registration No. 560), of Edison Laboratory, Orange, New Jersey, his attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the patent office connected therewith.

JONAS W AYLSWORTH.

## SPECIFICATION.

*To whom it may concern:*

*Be it known* that I, Jonas W. Aylsworth, of Orange, *12/27/04 a citizen of the United States residing at East Orange* in the County of Essex and State of New Jersey, have invented certain improvements in COMPOSITIONS FOR MAKING DUPLICATE PHONOGRAPH RECORDS, of which the following is a description:

My invention relates to a new composition adapted particularly for making duplicate phonograph records obtained by any suitable process from a matrix or mold, but the composition has been gotten up especially for making duplicate phonograph records obtained by the process described in patent to Miller and Aylsworth, No. 683,615, Dated October 1, 1901, and wherein a suitable mold carrying on its bore the negative representation of the record to be duplicated is immersed in a molten wax-like, coagulable material, which forms a coagulated layer of the desired thickness on the bore of the mold, after which the material is reamed out internally while warm, and the resulting duplicate removed by shrinking diametrically and removing the same longitudinally from the mold, its ends being finally finished.

The desirable properties or characteristics of my improved composition are such, however, that it may be effectively utilized for the manufacture of duplicate phonograph records obtained by means of any process wherein material in a molten or plastic condition is introduced into a matrix or mold, and is allowed to set or is expanded therein so as to take an impression, being removed by diametric shrinkage sufficient to clear the engaging surfaces. A composition suitable for the purpose should have certain peculiarities, which I have been able to secure only after long experiment.

In the first place, the composition should be very limpid when in a molten or plastic state, so as to flow into intimate engagement or contact with the record surface, and thereby permit a very sharp impression to be received. It should be free of decomposition products, which would otherwise result in the generation of gas, forming bubbles which would destroy the commercial character of the record surface. It should be of excessively fine texture or grain so as not to produce extraneous sounds when the producer was over it. It should be very hard when set, so as to reduce wear as much as possible, due to the tracking of the reproducer. It should have the capacity of passing from the liquid to the solid state through an intermediate condition of gradually reduced plasticity to thereby enable the duplicate to shrink internally and towards the surface, so as not to clear the mold until quite hard to thereby preserve the record, instead of chilling very rapidly at the surface to form a relatively hard film which tends to shrink away from the mold, even when the mass of the material is still molten; since I find that materials having this latter characteristic are not suitable for the purpose, owing to the danger of the record surface being injured under the effect of the unequal chilling. It should not be sticky or tenacious so as to adhere to the mold when set, even to the smallest extent. It should be capable of shrinking away from the mold when quite hard by a reduction in its temperature. It should have a very smooth and polished surface so as to eliminate foreign noises due to the tracking of the reproducer. It should be free from air and gas bubbles which, if present at the surface, would destroy the commercial character of any duplicates containing them. It should shrink uniformly without warping, so as to be capable of effective use with standard talking machines. It should not be affected by moisture, so as to be preserved in damp climates; and it should have a high melting point, so as not to soften in hot localities. When hot it should be capable of being cleanly cut in reaming without dragging or chipping, so as to present a smooth, clean surface on the bore of the duplicate. Preferably, it should be of a very dark color to permit imperfections to be better observed. It should be perfectly amorphous and non-crystalline, since the latter materials harden very quickly at the surface when their congealing temperature is reached, and shrink irregularly, with the objections pointed out.

The composition which I have invented, and which will be herein described, is one possessing these characteristics, and hence is especially adapted for use in this art. In describing my improved composition and the process which I prefer to follow in compounding the same, I shall refer to preferable proportions of ingredients, to preferable steps or procedures in the process, and to preferable temperatures, all based on actual practical experience in this art; but it will be understood that in these respects considerable variations may be made, as will be obvious to those *1/10/05 A* skilled in the art.

In making my improved composition, I prefer to proceed, therefore, substantially as follows: I first take one hundred pounds of commercial stearic acid, which, as is known, is generally a mixture of stearic and palmitic acids, and melt the same in a suitable galvanized iron caldron or other vessel at a tem-
240°
perature of about two hundred and forty degrees Fahrenheit.
136°
The stearic acid used melts at about one hundred and thirty-six degrees Fahrenheit. Care should be taken to see that the stearic acid is substantially free from oleic, as well as from mineral acids, salts, glycerine and undecomposed fats, as tallow, etc. It should also be free from mucillagenous substances and hydro-carbons. When the stearic acid is fully melted I then add to the same a water solution of carbonate of soda and aluminate of soda, obtained preferably in the following way: I first dissolve twenty-one and a half pounds of re-crystallized sodium-carbonate in a suitable steam-jacketed caldron of about twenty gallons capacity in ten gallons of water, and I add to the solution four hundred fifty-two grams of caustic soda of the best grade of the commercial article. When all is dissolved, I add one hundred seventy-five grams of metallic aluminum, preferably in the form of pieces about three inches by twelve inches square, and twenty one-thousandths of an inch in thickness. When the metal is added to the solution I turn off the heat and allow the metal to dissolve, which takes place inside of three hours. When all the metal is dissolved the solution is filtered while still hot in a filter press, or in any other way. In adding the alkaline solution to the melted stearic acid I gradually raise the temperature of the latter so as to correspond with the increased melting point of the mixture. The alkaline solution is added as rapidly as possible without unduly running the temperature down, or causing excessive boiling or foaming. The solution can be added quite rapidly at first, but towards the end it must be added very slowly. The addition of the alkaline solution to the stearic acid results in the production of stearates and palmitates of soda and of aluminum, the

latter being metallic soaps or metallic salts of fatty acids. During the saponification which thus takes place water is driven off. At the end of the operation the temperature will have gradually
360°
run up to about three hundred and sixty degrees Fahrenheit.

I now add to the molten metallic-soap mixture twenty-one and thirty-six hundredths pounds of a very hard wax, preferably carnauba, the latter consisting of a mixture or combination of the higher fatty acids and alcohols. The carnauba wax used should be as clean as possible, and it may be purified by melting the same with an equal weight of water, heating by a jet of direct steam and boiling for a short time, then drawing off or evaporating the water, after which it may be poured into pans where it is allowed to cool into cakes suitable for weighing. When the carnauba wax is added to the soap mixture, the tem-
450°
perature of the mass is raised to about four hundred and fifty degrees Fahrenheit, and maintained until all foaming ceases, which usually takes about five hours. By thus subjecting the mixture to a relatively high heat, combination is effected between the alcohols of the carnauba wax and the excessive stearic acid present in the metallic-soap composition, forming a hard, wax-like compound ether, which gives to the composition many of its desirable characteristics. Unless the carnauba wax is heated materially beyond its melting point, resulting in the reaction referred to taking place, the composition, although harder, is very brittle and shrinks excessively, and is, therefore, not so desirable as when the high heating is effected. Furthermore,
*likelihood*
*17/27/05* unless this is done, there is greater liklehood of decomposable products remaining in the composition, affecting the character thereof and resulting in the production of bubbles in the surface of the resulting duplicate.

After the treatment of the molten material at a high temperature has been effected, and all foaming has ceased, I add twenty-one and thirty-six hundredths pounds of ceresin thereto, although other hydro-carbon waxes may be employed, such as
*paraffine*
“ parrafine or ozocerite. The purpose of this latter ingredient is to make the mixture non-hygroscopic, and also less brittle than it otherwise would be.

When ceresin is used, its melting point should be
145°
preferably about one hundred forty-five degrees Fahrenheit, and in any event as high as can be obtained, and it should present a fine grain on fracture and
*paraffine*
*12/27/04* should be free from parrafine.

For the purpose of darkly coloring the composition a suitable amount of fine, pure lamp-black, say from .9% to 3% thereof, or other suitable, inert, finely pulverized pigment may be added to the molten mass at any stage of the operation. Preferably, however, the coloring matter is added together with the carnauba wax.

After the ceresin is added and thoroughly incorporated with the mixture, the congealing temperature of the latter may be regulated by adding free stearic acid thereto. In using the process described in the patent to Miller and Aylsworth, before referred to, I prefer to adjust the congealing point of the mixture
290°
at about two hundred and ninety degrees Fahrenheit, since excellent commercial results have been secured at that temperature. I find that in dealing with temperatures above two hundred and
290°
ninety degrees Fahrenheit the addition of one per cent. by weight
5°
of stearic acid effects a drop of about five degrees Fahrenheit in the congealing point. Obviously, this regulation of the congealing point of the mixture depends upon the special process which is to be followed in making duplicates, and where the congealing temperature is not important no attention whatever need be paid to its regulation. The material is now strained, preferably through open muslin, and is ready for use.

While I prefer in all cases to make use of carnauba wax as described, yet I find that bees-wax and Chinese-wax and palm-wax all contain alcohols somewhat similar to those of carnauba wax, and by which substantially similar reactions take place. These materials may, therefore, be substituted for the carnauba wax, but always at a sacrifice in the desirable condition of the resulting products.

Having now described my invention, what I claim as new therein and desire to secure by letters patent is as follows:

1. A composition for phonograph recording surfaces, having the following physical properties, (1)

*molten*

*11/15/04* it is very limpid when molded, (2) it presents a hard smooth surface when set, (3) it is non-hygroscopic, (4) it has a high melting point, and (5) it passes *12/27/04* from the liquid to the solid state through an intermediate condition of gradually reduced plasticity, substantially as set forth.

2. A composition for phonograph recording surfaces, having the following physical properties: (1)

*molten*

" it is very limpid when molded, (2) it presents a hard smooth surface when set, (3) it is non-hygroscopic, (4) it has a high melting point, (5) it passes from the liquid to the solid state through an intermediate condition of gradually reduced plasticity, and (6) it has a dark color, substantially as set forth.

3. *1* A composition for phonograph recording surfaces, comprising a metallic soap and a hard wax added thereto, substantially as set forth.

4. *2* A composition for phonograph recording surfaces, comprising a metallic soap and carnauba wax added thereto, substantially as set forth.

5. *3* A composition for phonograph recording surfaces, comprising a mixture of metallic soap, a hard wax and a non-hygroscopic ingredient, substantially as set forth.

6. *4* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, a hard wax, and ceresin, substantially as set forth.

7. *5* A composition for phonograph recording surfaces, comprising a mixture of metallic soap, carnauba wax and a non-hygroscopic ingredient, substantially as set forth.

8. *6* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, carnauba wax and ceresin, substantially as set forth.

9. *7* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap and wax-like compound ether, substantially as set forth.

10. *8.* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, a wax-like compound ether, and a non-hygroscopic ingredient, substantially as set forth.

11. *9* A composition for phonograph recording surfaces, comprising a mixture of metallic soap, a wax-like compound ether and ceresin, substantially as set forth.

12. *10* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, a hard wax, and a black pigment, substantially as set forth.

13. *11* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, a hard wax and lamp-black, substantially as set forth.

14. *12* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, carnauba wax and a black pigment, substantially as set forth.

15. *13* A compensation for phonograph recording surfaces, comprising a mixture of a metallic soap, carnauba wax and lamp-black, substantially as set forth.

16. *14* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, carnauba wax, ceresin and a black pigment, substantially as set forth.

17. *15* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, carnauba wax, ceresin and lamp-black, substantially as set forth.

18. *16* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, a wax-like compound ether, and a black pigment, substantially as set forth.

19. *17* A composition for phonograph recording surfaces, comprising a mixture of a metallic soap, a wax-like compound ether and lamp-black, substantially as set forth.

20. *18* A composition for phonograph recording surfaces, comprising a mixture of stearate of soda, carnauba wax, and a non-hygroscopic ingredient, substantially as set forth.

21. *19* A composition for phonograph recording surfaces, comprising a mixture of stearate of soda, carnauba wax and ceresin, substantially as set forth.

22. *20* A composition for phonograph recording surfaces, comprising a mixture of stearate of soda, carnauba wax and a black pigment, substantially as set forth.

23. *21* A composition for phonograph recording surfaces, comprising a stearate of soda, carnauba wax and lamp-black, substantially as set forth.

24. *22* A composition for phonograph recording surfaces, comprising a mixture of stearate of soda, stearate of alumina, and carnauba wax, substantially as set forth.

25. *23* A composition for phonograph recording surfaces, comprising a mixture of stearate of soda, stearatae of alumina, carnauba wax and lamp-black, substantially as set forth.

26. *24* A composition for phonograph recording *1/10/05* surfaces, comprising a mixture of stearate of soda, stearatē of alumina, carnauba wax and lamp-black, substantially as set forth.

27. *25 24* A composition for phonograph recording surfaces, comprising a mixture of stearate of soda, stearate of alumina, carnauba wax, ceresin and lamp-black, substantially as set forth.

This specification signed and witnessed this 29 day of Oct. 1903.

JONAS W. AYLSWORTH

Witness:

1. FRANK L. DYER.
2. WILLIAM A. DOLAN

## OATH.

STATE OF NEW JERSEY, } *ss.:*
*County of Essex,*

JONAS W. AYLSWORTH, the above-named petitioner, being duly sworn, deposes and says that he is a citizen of the United States, and a resident of East Orange, in the County Essex and State of New Jersey; and that he verily believes himself to be the original, first and sole invĕntor of the COMPOSITION FOR MAKING DUPLICATE PHONOGRAPH RECORDS described and claimed in the annexed specification: that he does not know and does not believe that the same was ever known or used by others in the United States of America before his invention or discovery thereof: or patented or described in any printed publication in the United States of America or any foreign country before his invention or discovery thereof, or more than two years prior to this application; or in public use or on sale in the United States for more than two years prior to this application, and that no application for patent upon said invention has been filed by him or his legal representative or assigns in any foreign country more than seven months prior to the filing of this application.

JONAS W AYLSWORTH.

Sworn to and subscribed before me this 29th day of Oct. 1903.

FRANK L. DYER.
*Notary Public.*

(Notarial Seal) *Notary Public, State of New Jersey,*
*Commission Expires, February, 1908.*

2—260.

Div......... Room 379. Paper No. 1, Rejection.

J. H. D.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., December 3, 1903.
Mailed " " "

Jonas W. Aylsworth,
Care Frank L. Dyer,
Edison Laboratory,
Orange, New Jersey.

Please find below a communication from the Examiner in charge of your application, for Composition for Making Duplicate Phonograph Records, filed Nov. 3, 1903, serial number 179,729.

F. I. ALLEN
*Commissioner of Patents.*

The composition of matter that applicant claims seems to consist of ingredients merely whose properties are well known in this art, and it cannot be seen how invention can be displayed in assembling these ingredients. It is already known why it is desirable to use the ingredients named by applicant, as shown in the following patents:

Tainter, Nov. 20, 1888, # 393,190, Tablets;
Edison, April 2, 1889, # 400,648, Tablets;
Edison, Nov. 12, 1889, # 414,750, Tablets;
Edison, July 9, 1889, # 406,576, Tablets;
Macdonald, July 5, 1898, # 606,725, Graph. Tablets, Methods and Machines for making, and
Aylsworth, July 11, 1901, # 676,111, Tablets.

To add any given pigment to a composition of matter to give the latter any given color cannot constitute patentable invention.

The claims are rejected for want of patentable invention and novelty, in view of the patents cited.

J. T. NEWTON *Ex*

J.H.L.

Mail Room
Nov
15
1904
U. S. Patent Office.

*No. 2*
Amdt.
*11/15/04*

UNITED STATES PATENT OFFICE.

Jonas W. Aylsworth,
COMPOSITION FOR MAKING DUPLICATE
PHONOGRAPH RECORDS.
Filed November 3, 1903,
Serial No. 179,729.

*Honorable Commissioner of Patents,*

SIR:—Replying to office action of December 3, 1903, please amend the above entitled case as follows;

Page 1, line 3, change "or" to—of.

Claim 1, line 3, change "molded" to —molten.

Claim 2, line 3, change "molded" to—molten.

A reconsideration of the rejection of the claims is respectfully requested.

REMARKS.

It is submitted that applicant has produced a composition which is novel and is possessed of properties which adapt it very perfectly the to the purposes for which it is designed. Although ingredients have *separately* been used for the making of sound records, they have not been used together or in such a way that the peculiar properties of the ingredients could be utilized in combination.

Thus, the use of carnauba wax was explained by Tainter in patent No. 393,190, but it was used together with a soft wax, merely for the purpose of increasing the hardness of the composition. This is different function from that which carnauba wax performs in applicant's composition, wherein it is mixed with a metallic soap containing an excess of stearic acid and preferably reacts thereon to form a hard wax-like compound ether.

In Edison patent No. 406,576, a carnauba wax is mixed with asphalt to form the *base* of a tablet which is afterwards *coated* with a substance for receiving the record, the wax being used in order to cause the mixture (asphalt and wax) to shrink when cooled, so that it may be drawn from the mold. The disclosure of this patent fails to anticipate the present invention, since the base composition is not used as a phonograph recording surface, and furthermore, it does not contain any metallic soap, and there is no wax-like combined ether, as called for by certain of the claims.

The patents which have been considered are the only ones in which carnauba wax or a hard wax is used. The remaining references therefore all fail as anticipations of such claims as specifying carnauba wax or a hard wax or a wax-like compound ether, and, it is therefore unnecessary to consider them in detail.

Claims 1 and 2 specify a composition possessed of certain properties which are believed to be absent from all the references.

A reconsideration and allowance of the claims is respectfully solicited.

JONAS W. AYLSWORTH,
By FRANK L. DYER
*His Attorney.*

Orange, New Jersey.
November 14 1904.

2—260.

Div. 23 Room 379 Paper No. 3, Rej.

J. H. D.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.
WASHINGTON, D. C., December 21, 1904.
Mailed " " "

JONAS W. AYLSWORTH,
Care FRANK L. DYER,
Edison Laboratory,
Orange, New Jersey.

Please find below a communication from the Examiner in charge of your application, for Composition for Making Duplicate Phonograph Records, filed Nov. 3, 1903, serial number 179,729.

F. I. ALLEN
*Commissioner of Patents.*

This action is in response to the amendment filed the 15th ultimo.

Raymond R. Wile Research Library

Claims 1 and 2 are rejected in view of any one of the patents cited.

The remaining claims may be allowed.

J. H. L. J. T. NEWTON *Ex*

Mail Room
Dec
27
1904
U. S. Patent Office.

*No. 4*
*Amdt.*

UNITED STATES PATENT OFFICE.

Jonas W. Aylsworth,
COMPOSITION FOR MAKING DUPLICATE
PHONOGRAPH RECORDS
Filed November 3, 1903,
Serial No. 179,729,
} Room No. 379

*Honorable Commissioner of Patents,*

SIR: Replying to office action of December 21, 1904, please amend the above entitled case as follows:

Page 1, line 3, cancel "of Orange" and insert in place thereof—a citizen of the United States residing at East Orange.

Page 5, line 9 from tthe bottom, correct the spelling of likelihood.

Same page, last line and page 6, line 6, correct the spelling of paraffine.

Although applicant does not admit that any of the references disclose a composition having the physical properties set forth in his first two claims, yet, in view of the fact that the invention would apparently be adequately protected by the remaining claims, and since applicant does not desire to further delay the issuance of the patent, he hereby authorizes and requests the cancellation of claims 1 and 2, and the renumbering of the remaining claims.

Respectfully,
JONAS W. AYLSWORTH,
By FRANK L. DYER
*His Attorney.*

Orange, N. J.
December 24, 1904.

2—260.

Div. 23 Room 379 Paper No. 5, Letter

J. H. D.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., January 4, 1905.
Mailed " " "

Jonas W. Aylsworth,
Care Frank L. Dyer,
Edison Laboratory,
Orange, New Jersey.

Please find below a communication from the Examiner in charge of your application, for Composition for Making Duplicate Phonograph Records, filed Nov. 3, 1903, serial number 179,729.

F. I. ALLEN
*Commissioner of Patents.*

This action is in response to the amendment filed the 27th ultimo.

Applicant is requested to file a drawing representing a conventional sound record having inscribed thereon the names of the ingredients of the composition of matter claimed.

J. T. NEWTON *Ex*

J.H.L.

Mail Room
Jan
10
1905
U. S. Patent Office.

*No. 6*
*Amdt. A.*
*1/10/05*

UNITED STATES PATENT OFFICE.

Jonas W. Aylsworth,
COMPOSITION FOR MAKING DUPLICATE
PHONOGRAPH RECORDS
Filed November 3, 1903
Serial No. 179,729.
Room No. 379.

*Honorable Commissioner of Patents,*

SIR: Please amend the above entitled case as follows:

Page 3 after line 23, insert the following paragraph:

> Reference is hereby made to the accompanying drawing, which shows in perspectve a phonograph record, having
> *A* inscribed thereon the names of ingredients which are preferably used in the preparation of my invention.

Cancel claim 26, and renumber claim 27 as 26.

## REMARKS

Claim 26 has been cancelled as being a duplicate of claim 25.

A drawing has been filed in accordance with the Examiner's requirement of January 4, 1905.

The case is believed to be in condition for allowance, which is respectfully solicited.

JONAS W. AYLSWORTH,
By FRANK L. DYER.
*His Attorney.*

Orange, N. J.
January 9 1905.

Mail Room
Jan
10
1905
U. S. Patent Office.

*No. 7*
*Amdt. to Dig.*

## UNITED STATES PATENT OFFICE.

Jonas W. Aylsworth
COMPOSITION FOR MAKING DUPLICATE
PHONOGRAPH RECORDS
Filed November 3, 1903
Serial No. 179,729
Room No. 379.

*Honorable Commissioner of Patents*

SIR—Please file the accompanying drawing in the above entitled application as requested by the Examiner in the official letter of January 4, 1905.

Respectfully,
THOMAS A. EDISON
By FRANK L. DYER,
*His Attorney.*

Orange, N. J.
January 9 1905.

M. L. A. 2—181.

ISSUE DIVISION. Serial No. 179,729.

*All communications should be addressed to*
"The Commissioner of Patents,
Washington, D. C."

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Jan. 18, 1905.

Jonas W. Aylsworth, Assor.,
C/o Frank L. Dyer,
Edison Laboratory,
Orange, N. J.

SIR—Your application for a patent for an improvement in Composition for Making Duplicate Phonograph Records filed Nov. 3, 1903, has been examined and allowed.

The final fee, Twenty Dollars, must be paid, and the Letters Patent bear date as of a day not later than six months from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The Office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least twenty days prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, distinctly and plainly written, the name of the Inventor and Title of Invention as above given, date of allowance (which is the date of this circular), date of filing, and, if assigned, the names of the assignees.

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of five cents each. The money should accompany the order. Postage stamps will not be received.

Very respectfully,

F. I. ALLEN
*Commissioner of Patents.*

☞ In remitting the final fee give the serial number at the head of this notice.

☞ If payment is made by check or draft, the credit allowed is subject to the collection of the same.

**☞ After allowan [illegible] ior to payment of the final fee, applicants should carefully scrutinize the description to see that their statements and language are correct, as mistakes not incurred through the fault of the office, and not affording legal grounds for reissues, will not be corrected after the delivery of the letters patent to the patentee or his agent.**

$ *20 ck* Received
Jan
23 *J.*
1905.
Chief Clerk, U. S. Patent Office.

ORANGE, N. J., Jan. 21, 1905.

*Honorable Commissioner of Patents,*
*Washington, D. C.*

SIR—Enclosed I beg to hand you check for $20. in payment of the final government fee on the application of Jonas W. Aylsworth filed Nov. 3, 1903 for composition for making duplicate phonograph records, Serial No. 179,729, allowed January 18, 1905 and assigned to the New Jersey Patent Company to whom the patent should issue..

Very respectfully,
FRANK L. DYER.

Fld/Ark.
(Enc.)

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C. E. R. 2—191. SERIAL No. 179,729.

*Issue Division.*

***All communications should be addressed to***
**"The Commissioner of Patents,**
**Washington, D. C."**

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Jan. 23, 1905.

Jonas W. Aylsworth, Assor.
C/o Frank L. Dyer,
Edison Laboratory,
Orange, N. J.

SIR—You are informed that the final fee of TWENTY DOLLARS has been received in your application for Improvement in Composition for Making Duplicate Phonograph Records.

Very respectfully,
F. I. ALLEN,
*Commissioner of Patents.*

Raymond R. Wile Research Library

(Letters Patent No. 782,375 follows here.)

Number (Series of 1900.) Div. No. 23
*179,729* 1903 Ex'r's Book 73

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10
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Patent No. 782375 (03)
Name Jonas W. Aylsworth
Assor to New Jersey Patent Company, of Orange, N. J., a corp. of New Jersey.
of East Orange
County of
State of New Jersey
Invention
Composition for Making Duplicate Phonograph Records.

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| Patented | February 14, | , 1905 |

Associate Attorney Attorney FRANK L. DYER,
Edison Laboratory
Orange, New Jersey.

Name Serial Number
Patent No. Date of Patent

Raymond R. Wile Research Library

1903 *M. B.*

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TITLE:

Improvement in Composition for Making
Duplicate Phonograph Records.

J. G. W.
A. S. M.

2—389.

# UNITED STATES OF AMERICA

## Department of the Interior,

### PATENT OFFICE.

U. S. Circuit Court
District of New Jersey
New Jersey Patent Co. Genl.
v
Columbia Phon. Co.
In Equity
Complainants Exhibit
Patent in Suit

To all persons to whom these presents shall come, Greeting:

**This is to certify** *That the annexed is a true copy from the* Records *of this office* of the Letters Patent of Jonas W. Aylsworth, Assignor to New Jersey Patent Company. Number 782,375, granted February 14 1905, for Improvement in Compositions for Making Duplicate Phonograph Records.

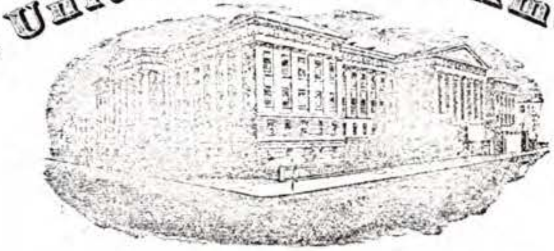
**In testimony whereof** *I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this* 12th *day of* June*, in the year of our Lord one thousand nine hundred* and five *and of the Independence of the United States of America the one hundred and twenty-*ninth

F. I. Allen
Commissioner of Patents.

No. 782,375

2—366.

# The United States of America,



**To all to whom these Presents shall come:**

**Whereas** Jonas W. Aylsworth,

of East Orange, New Jersey,

has presented to the Commissioner of Patents a petition praying for the grant of **LETTERS PATENT** for an alleged new and useful improvement in Compositions for Making Duplicate Phonograph Records. He having assigned his right, title, and interest, in said improvement, to New Jersey Patent Company of Orange, New Jersey, a corporation of New Jersey, a description of which invention is contained in the Specification of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of Law in such cases made and provided; and

**Whereas** upon due examination made the said Claimant is adjudged to be justly entitled to a Patent under the Law.

**Now, therefore,** these **LETTERS PATENT** are to grant unto the said New Jersey Patent Company its successors ~~heirs~~ or assigns for the term of seventeen years from the fourteenth day of February, one thousand nine hundred and five, the exclusive right to make, use, and vend the said invention throughout the United States and the Territories thereof.

**In testimony whereof** I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this fourteenth day of February, in the year of our Lord one thousand nine hundred and five, and of the Independence of the United States of America the one hundred and twenty-ninth.

F. I. Allen

Commissioner of Patents.

10871b5m12-03

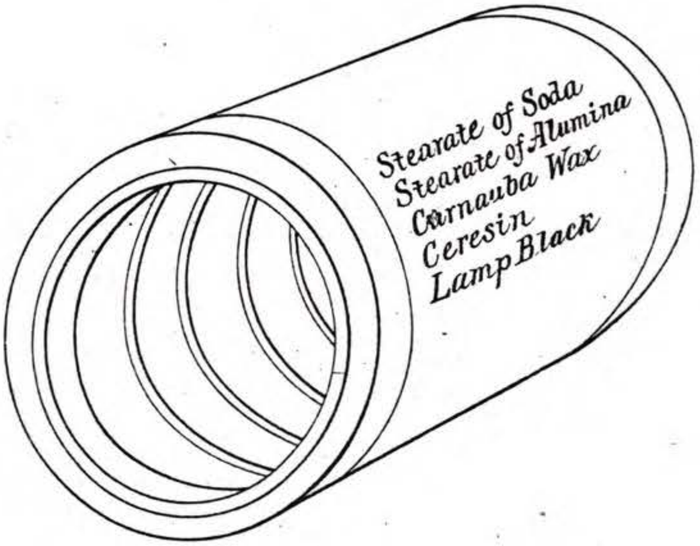
J.H.

No. 782,375. PATENTED FEB. 14, 1905.

J. W. AYLSWORTH.

COMPOSITION FOR MAKING DUPLICATE PHONOGRAPH RECORDS.

APPLICATION FILED NOV. 3, 1903.



Attest:
Edgeworth Greene
Delos Holden

Inventor:
Jonas W. Aylsworth
by Frank L. Dyer
Atty.

**No. 782,375.** **Patented February 14, 1905.**

# UNITED STATES PATENT OFFICE.

JONAS W. AYLSWORTH, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO NEW JERSEY PATENT COMPANY, OF ORANGE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

## COMPOSITION FOR MAKING DUPLICATE PHONOGRAPH-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 782,375, dated February 14, 1905.

Application filed November 3, 1903. Serial No. 179,729.

*To all whom it may concern:*

Be it known that I, JONAS W. AYLSWORTH, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain Improvements in Compositions for Making Duplicate Phonograph-Records, of which the following is a description.

My invention relates to a new composition adapted particularly for making duplicate phonograph-records obtained by any suitable process from a matrix or mold; but the composition has been gotten up especially for making duplicate phonograph-records obtained by the process described in patent to Miller and Aylsworth, No. 683,615, dated October 1, 1901, and wherein a suitable mold carrying on its bore the negative representation of the record to be duplicated is immersed in a molten wax-like coagulable material, which forms a coagulated layer of the desired thickness on the bore of the mold, after which the material is reamed out internally while warm and the resulting duplicate removed by shrinking diametrically and removing the same longitudinally from the mold, its ends being finally finished. The desirable properties or characteristics of my improved composition are such, however, that it may be effectively utilized for the manufacture of duplicate phonograph-records obtained by means of any process wherein material in a molten or plastic condition is introduced into a matrix or mold and is allowed to set or is expanded therein so as to take an impression, being removed by diametric shrinkage sufficient to clear the engaging surfaces.

A composition suitable for the purpose should have certain peculiarities, which I have been able to secure only after long experiment. In the first place, the composition should be very limpid when in a molten or plastic state, so as to flow into intimate engagement or contact with the record-surface, and thereby permit a very sharp impression to be received. It should be free of decomposition products, which would otherwise result in the generation of gas, forming bubbles, which would destroy the commercial character of the record-surface. It should be of excessively-fine texture or grain, so as not to produce extraneous sounds when the reproducer rubs over it. It should be very hard when set, so as to reduce wear as much as possible, due to the tracking of the reproducer. It should have the capacity of passing from the liquid to the solid state through an intermediate condition of gradually-reduced plasticity, to thereby enable the duplicate to shrink internally and toward the surface, so as not to clear the mold until quite hard, to thereby preserve the record, instead of chilling very rapidly at the surface to form a relatively hard film, which tends to shrink away from the mold even when the mass of the material is still molten, since I find that materials having this latter characteristic are not suitable for the purpose, owing to the danger of the record-surface being injured under the effect of the unequal chilling. It should not be sticky or tenacious, so as to adhere to the mold when set, even to the smallest extent. It should be capable of shrinking away from the mold when quite hard by a reduction in its temperature. It should have a very smooth and polished surface, so as to eliminate foreign noises due to the tracking of the reproducer. It should be free from air and gas bubbles, which if present at the surface would destroy the commercial character of any duplicates containing them. It should shrink uniformly without warping, so as to be capable of effective use with standard talking-machines. It should not be affected by moisture, so as to be preserved in damp climates; and it should have a high melting-point, so as not to soften in hot localities. When hot, it should be capable of being cleanly cut in reaming without dragging or chipping, so as to present a smooth clean surface on the bore of the duplicate. Preferably it should be of a very dark color to permit imperfections to be better observed. It should be perfectly amorphous and non-crystalline; since the latter materials harden very quickly at the surface when their congealing temperature is reached and shrink irregularly, with the objections pointed out. The composition which I have invented and which will be herein described is one possessing these characteristics, and hence is especially adapted for use in this art.

In describing my improved composition and the process which I prefer to follow in compounding the same I shall refer to preferable proportions of ingredients, to preferable steps or procedures in the process, and to preferable temperatures, all based on actual practical experience in this art; but it will be understood that in these respects considerable variations may be made, as will be obvious to those skilled in the art.

Reference is hereby made to the accompanying drawing, which shows in perspective a phonograph-record having inscribed thereon the names of ingredients which are preferably used in the preparation of my invention.

In making my improved composition I prefer to proceed, therefore, substantially as follows:

I first take one hundred pounds of commercial stearic acid, which, as is known, is generally a mixture of stearic and palmitic acids, and melt the same in a suitable galvanized-iron caldron or other vessel at a temperature of about 240° Fahrenheit. The stearic acid used melts at about 136° Fahrenheit. Care should be taken to see that the stearic acid is substantially free from oleic acid, as well as from mineral acids, salts, glycerin, and undecomposed fats, as tallow, &c. It should also be free from mucilaginous substances and hydrocarbons. When the stearic acid is fully melted, I then add to the same a water solution of carbonate of soda and aluminate of soda, obtained, preferably, in the following way: I first dissolve twenty-one and a half pounds of recrystallized sodium carbonate, in a suitable steam-jacketed caldron of about twenty gallons capacity, in ten gallons of water, and I add to the solution four hundred and fifty-two grams of caustic soda of the best grade of the commercial article. When all is dissolved, I add one hundred and seventy-five grams of metallic aluminium, preferably in the form of pieces about three inches by twelve inches square and twenty one-thousandths of an inch in thickness. When the metal is added to the solution, I turn off the heat and allow the metal to dissolve, which takes place inside of three hours. When all the metal is dissolved, the solution is filtered while still hot in a filter-press or in any other way. In adding the alkaline solution to the melted stearic acid I gradually raise the temperature of the latter so as to correspond with the increased melting-point of the mixture. The alkaline solution is added as rapidly as possible without unduly running the temperature down or causing excessive boiling or foaming. The solution can be added quite rapidly at first; but toward the end it must be added very slowly. The addition of the alkaline solution to the stearic acid results in the production of stearates and palmitates of soda and of aluminium, the latter being metallic soaps or metallic salts of fatty acids. During the saponification which thus takes place water is driven off. At the end of the operation the temperature will have gradually run up to about 360° Fahrenheit. I now add to the molten metallic-soap mixture twenty-one and thirty-six hundredths pounds of a very hard wax, preferably carnauba, the latter consisting of a mixture or combination of the higher fatty acids and alcohols. The carnauba-wax used should be as clean as possible, and it may be purified by melting the same with an equal weight of water, heating by a jet of direct steam and boiling for a short time, then drawing off or evaporating the water, after which it may be poured into pans, where it is allowed to cool into cakes suitable for weighing. When the carnauba-wax is added to the soap mixture, the temperature of the mass is raised to about 450° Fahrenheit and maintained until all foaming ceases, which usually takes about five hours. By thus subjecting the mixture to a relatively high heat a combination is effected between the alcohols of the carnauba-wax and the excessive stearic acid present in the metallic-soap composition, forming a hard wax-like compound ether, which gives to the composition many of its desirable characteristics. Unless the carnauba-wax is heated materially beyond its melting-point, resulting in the reaction referred to taking place, the composition, although harder, is very brittle and shrinks excessively and is therefore not so desirable as when the high heating is effected. Furthermore, unless this is done there is greater likelihood of decomposable products remaining in the composition, affecting the character thereof and resulting in the production of bubbles in the surface of the resulting duplicate.

After the treatment of the molten material at a high temperature has been effected and all foaming has ceased I add twenty-one and thirty-six hundredths pounds of ceresin thereto, although other hydrocarbon waxes may be employed, such as paraffin or ozocerite. The purpose of this latter ingredient is to make the mixture non-hygroscopic and also less brittle than it otherwise would be. When ceresin is used, its melting-point should be, preferably, about 145° Fahrenheit, and in any event as high as can be obtained, and it should present a fine grain on fracture and should be free from paraffin.

For the purpose of darkly coloring the composition a suitable amount of fine pure lampblack—say from .9 per cent. to three per cent. thereof—or other suitable inert finely-pulverized pigment may be added to the molten mass at any stage of the operation. Preferably, however, the coloring-matter is added together with the carnauba-wax.

After the ceresin is added and thoroughly incorporated with the mixture the congealing temperature of the latter may be regulated by adding free stearic acid thereto. In using the process described in the patent to Miller and Aylsworth, before referred to, I prefer to adjust the congealing-point of the mixture at about 290° Fahrenheit, since excellent commercial results have been secured at that temperature. I find that in dealing with temperatures above 290° Fahrenheit the addition of one per cent., by weight, of stearic acid effects a drop of about 5° Fahrenheit in the congealing-point. Obviously this regulation of the congealing-point of the mixture depends upon the special process which is to be followed in making duplicates, and where the congealing temperature is not important no attention whatever need be paid to its regulation. The material is now strained, preferably through open muslin, and is ready for use.

While I prefer in all cases to make use of caranuba-wax, as described, yet I find that beeswax and Chinese wax and palm-wax all contain alcohols somewhat similar to those of carnauba-wax and by which substantially similar reactions take place. These materials may therefore be substituted for the carnauba-wax, but always at a sacrifice in the desirable condition of the resulting products.

Having now described my invention, what I claim as new therein, and desire to secure by Letters Patent, is as follows:

1. A composition for phonograph recording-surfaces, comprising a metallic soap and a hard wax added thereto, substantially as set forth.

2. A composition for phonograph recording-surfaces, comprising a metallic soap and carnauba-wax added thereto, substantially as set forth.

3. A composition for phonograph recording-surfaces, comprising a mixture of metallic soap, a hard wax and a non-hygroscopic ingredient, substantially as set forth.

4. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a hard wax, and ceresin, substantially as set forth.

5. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and a non-hygroscopic ingredient, substantially as set forth.

6. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and ceresin, substantially as set forth.

7. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap and a wax-like compound ether, substantially as set forth.

8. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether, and a non-hygroscopic ingredient, substantially as set forth.

9. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether and ceresin, substantially as set forth.

10. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a hard wax and a black pigment, substantially as set forth.

11. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a hard wax and lampblack, substantially as set forth.

12. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and a black pigment, substantially as set forth.

13. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and lampblack, substantially as set forth.

14. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax, ceresin and a black pigment, substantially as set forth.

15. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax, ceresin and lampblack, substantially as set forth.

16. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether, and a black pigment, substantially as set forth.

17. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether and lampblack, substantially as set forth.

18. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, carnauba-wax, and a non-hygroscopic ingredient, substantially as set forth.

19. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, carnauba-wax and ceresin, substantially as set forth.

20. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, carnauba-wax and a black pigment, substantially as set forth.

21. A composition for phonograph recording-surfaces, comprising a stearate of soda, carnauba-wax and lampblack, substantially as set forth.

22. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, stearate of alumina, and carnauba-wax, substantially as set forth.

23. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, stearate of alumina, carnauba-wax and lampblack, substantially as set forth.

24. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, stearate of alumina, carnauba-wax, ceresin and lampblack, substantially as set forth.

This specification signed and witnessed this 29th day of October, 1903.

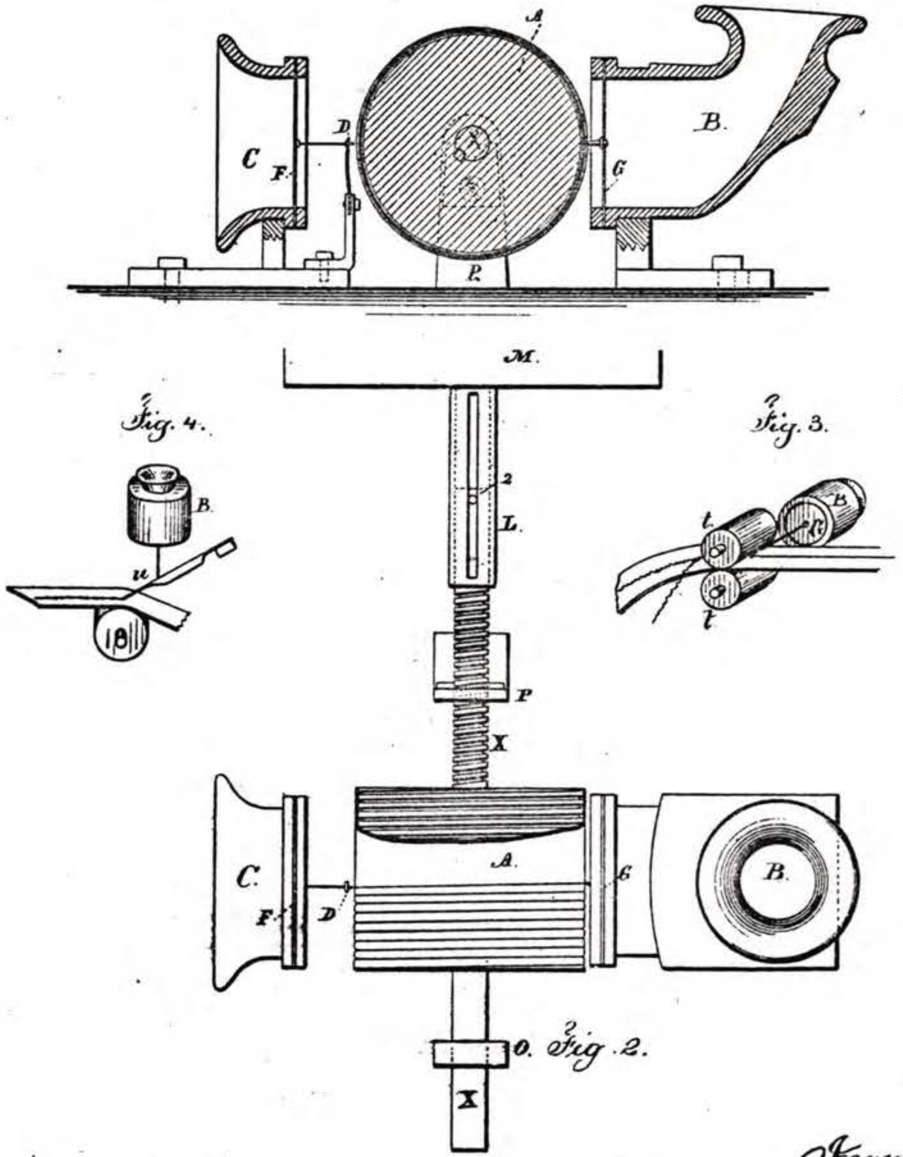
JONAS W. AYLSWORTH.

Witnesses:
FRANK L. DYER,
WILLIAM A. DOLAN.

T A. EDISON.

Phonograph or Speaking Machine.

No. 200,521. Patented Feb. 19, 1878.



Witnesses

Chas H. Smith

Harold Serrell

Inventor

Thomas A. Edison.

per Lemuel W. Serrell

atty.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

## IMPROVEMENT IN PHONOGRAPH OR SPEAKING MACHINES.

Specification forming part of Letters Patent No. **200,521**, dated February 19, 1878; application filed December 24, 1877.

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an Improvement in Phonograph or Speaking Machines, of which the following is a specification:

The object of this invention is to record in permanent characters the human voice and other sounds, from which characters such sounds may be reproduced and rendered audible again at a future time.

The invention consists in arranging a plate, diaphragm, or other flexible body capable of being vibrated by the human voice or other sounds, in conjunction with a material capable of registering the movements of such vibrating body by embossing or indenting or altering such material, in such a manner that such register-marks will be sufficient to cause a second vibrating plate or body to be set in motion by them, and thus reproduce the motions of the first vibrating body.

The invention further consists in the various combinations of mechanism to carry out my invention.

I have discovered, after a long series of experiments, that a diaphragm or other body capable of being set in motion by the human voice does not give, except in rare instances, superimposed vibrations, as has heretofore been supposed, but that each vibration is separate and distinct, and therefore it becomes possible to record and reproduce the sounds of the human voice.

In the drawings, Figure 1 is a vertical section, illustrating my invention, and Fig. 2 is a plan of the same.

A is a cylinder having a helical indenting-groove cut from end to end—say, ten grooves to the inch. Upon this is placed the material to be indented, preferably metallic foil. This drum or cylinder is secured to a shaft, X, having at one end a thread cut with ten threads to the inch, the bearing P also having a thread cut in it.

L is a tube, provided with a longitudinal slot, and it is rotated by the clock-work at M, or other source of power.

The shaft X passes into the tube L, and it is rotated by a pin, 2, secured to the shaft, and passing through the slot on the tube L, the object of the long slot being to allow the shaft X to pass endwise through the center or support P by the action of the screw on X. At the same time that the cylinder is rotated it passes toward the support O.

B is the speaking-tube or mouth-piece, which may be of any desired character, so long as proper slots or holes are provided to re-enforce the hissing consonants. Devices to effect this object are shown in my application, No. 143, filed August 23, 1877. Hence they are not shown or further described herein.

Upon the end of the tube or mouth-piece is a diaphragm, having an indenting-point of hard material secured to its center, and so arranged in relation to the cylinder A that the point will be exactly opposite the groove in the cylinder at any position the cylinder may occupy in its forward rotary movement.

The speaking-tube is arranged upon a standard, which, in practice, I provide with devices for causing the tube to approach and recede from the cylinder.

The operation of recording is as follows: The cylinder is, by the action of the screw in X, placed adjacent to the pillar P, which brings the indenting-point of the diaphragm G opposite the first groove on the cylinder, over which is placed a sheet of thick metallic foil, paper, or other yielding material. The tube B is then adjusted toward the cylinder until the indenting-point touches the material and indents it slightly. The clock-work is then set running, and words spoken in the tube B will cause the diaphragm to take up every vibration, and these movements will be recorded with surprising accuracy by indentations in the foil.

After the foil on the cylinder has received the required indentations, or passed to its full limit toward O, it is made to return to P by proper means, and the indented material is brought to a position for reproducing and rendering audible the sounds that had been made by the person speaking into the tube B.

C is a tube similar to B, except that the diaphragm is somewhat lighter and more sensitive, although this is not actually necessary. In front of this diaphragm is a light spring, D, having a small point shorter and finer than the indenting-point on the diaphragm of B. This spring and point are so arranged as to fall exactly into the path of all the indentations. This spring is connected to the diaphragm F of C by a thread or other substance capable of conveying the movements of D. Now, when the cylinder is allowed to rotate, the spring D is set in motion by each indentation corresponding to its depth and length. This motion is conveyed to the diaphragm either by vibrations through a thread or directly by connecting the spring to the diaphragm F, and these motions being due to the indentations, which are an exact record of every movement of the first diaphragm, the voice of the speaker is reproduced exactly and clearly, and with sufficient volume to be heard at some distance.

The indented material may be detached from the machine and preserved for any length of time, and by replacing the foil in a proper manner the original speaker's voice can be reproduced, and the same may be repeated frequently, as the foil is not changed in shape if the apparatus is properly adjusted.

The record, if it be upon tin-foil, may be stereotyped by means of the plaster-of-paris process, and from the stereotype multiple copies may be made expeditiously and cheaply by casting or by pressing tin-foil or other material upon it. This is valuable when musical compositions are required for numerous machines.

It is obvious that many forms of mechanism may be used to give motion to the material to be indented. For instance, a revolving plate may have a volute spiral cut both on its upper and lower surfaces, on the top of which the foil or indenting material is laid and secured in a proper manner. A two-part arm is used with this disk, the portion beneath the disk having a point in the lower groove, and the portion above the disk carrying the speaking and receiving diaphragmic devices, which arm is caused, by the volute spiral groove upon the lower surface, to swing gradually from near the center to the outer circumference of the plate as it is revolved, or vice versa.

An apparatus of this general character adapted to a magnet that indents the paper is shown in my application for a patent, No. 123, filed March 26, 1877; hence no claim is made herein to such apparatus, and further description of the same is unnecessary.

A wide continuous roll of material may be used, the diaphragmic devices being reciprocated by proper mechanical devices backward and forward over the roll as it passes forward; or a narrow strip like that in a Morse register may be moved in contact with the indenting-point, and from this the sounds may be reproduced. The material employed for this purpose may be soft paper saturated or coated with paraffine or similar material, with a sheet of metal foil on the surface thereof to receive the impression from the indenting-point.

I do not wish to confine myself to reproducing sound by indentations only, as the transmitting or recording device may be in a sinuous form, resulting from the use of a thread passing with paper beneath the pressure-rollers *t*, (see Fig. 3,) such thread being moved laterally by a fork or eye adjacent to the roller *t*, and receiving its motion from the diaphragm G, with which such fork or eye is connected, and thus record the movement of the diaphragm by the impression of the thread in the paper to the right and left of a straight line, from which indentation the receiving-diaphragm may receive its motion and the sound be reproduced, substantially in the manner I have already shown; or the diaphragm may, by its motion, give more or less pressure to an inking-pen, *u*, Fig. 4, the point of which rests upon paper or other material moved along regularly beneath the point of the pen, thus causing more or less ink to be deposited upon the material, according to the greater or lesser movement of the diaphragm. These ink-marks serve to give motion to a second diaphragm when the paper containing such marks is drawn along beneath the end of a lever resting upon them and connected to such diaphragm, the lever and diaphragm being moved by the friction between the point being greatest, or the thickness of the ink being greater where there is a large quantity of ink than where there is a small quantity. Thus the original sound-vibrations are reproduced upon the second diaphragm.

I claim as my invention—

1. The method herein specified of reproducing the human voice or other sounds by causing the sound-vibrations to be recorded, substantially as specified, and obtaining motion from that record, substantially as set forth, for the reproduction of the sound-vibrations.

2. The combination, with a diaphragm exposed to sound-vibrations, of a moving surface of yielding material—such as metallic foil—upon which marks are made corresponding to the sound-vibrations, and of a character adapted to use in the reproduction of the sound, substantially as set forth.

3. The combination, with a surface having marks thereon corresponding to sound-vibrations, of a point receiving motion from such marks, and a diaphragm connected to said point, and responding to the motion of the point, substantially as set forth.

4. In an instrument for making a record of sound-vibrations, the combination, with the diaphragm and point, of a cylinder having a helical groove and means for revolving the cylinder and communicating an end movement corresponding to the inclination of the helical groove, substantially as set forth.

Signed by me this 15th day of December, A. D. 1877.

THOS. A. EDISON.

Witnesses:
GEO. T. PINCKNEY,
CHAS. H. SMITH.

(No Model.) 5 Sheets—Sheet 1.

# C. C. REYNOLDS.

## PHONOGRAPH.

No. 287,166. Patented Oct. 23, 1883.

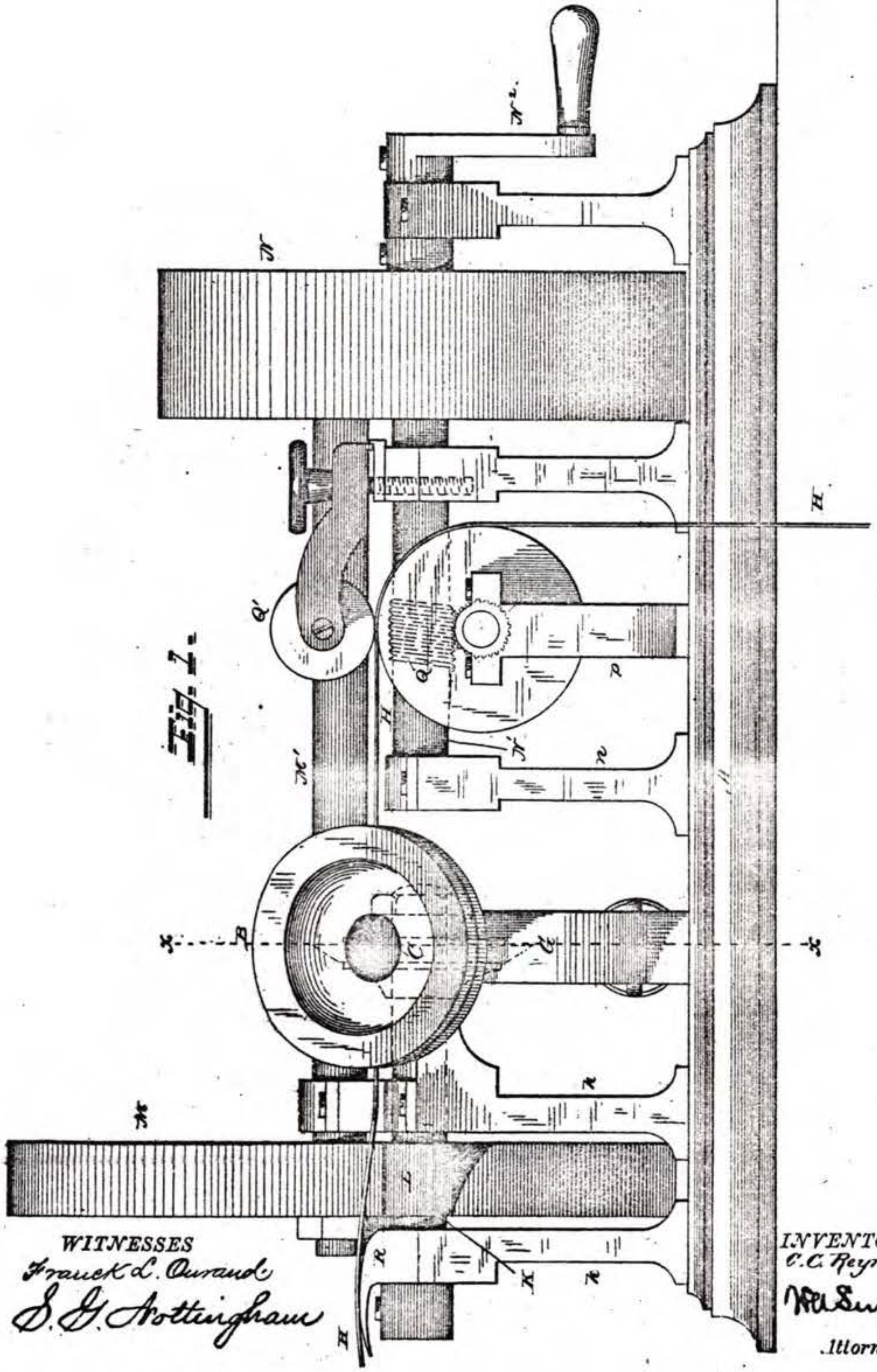


Fig. 1.

WITNESSES
Franck L. Ourand
S. G. Nottingham

INVENTOR
C. C. Reynolds
W. A. Seymour
Attorney

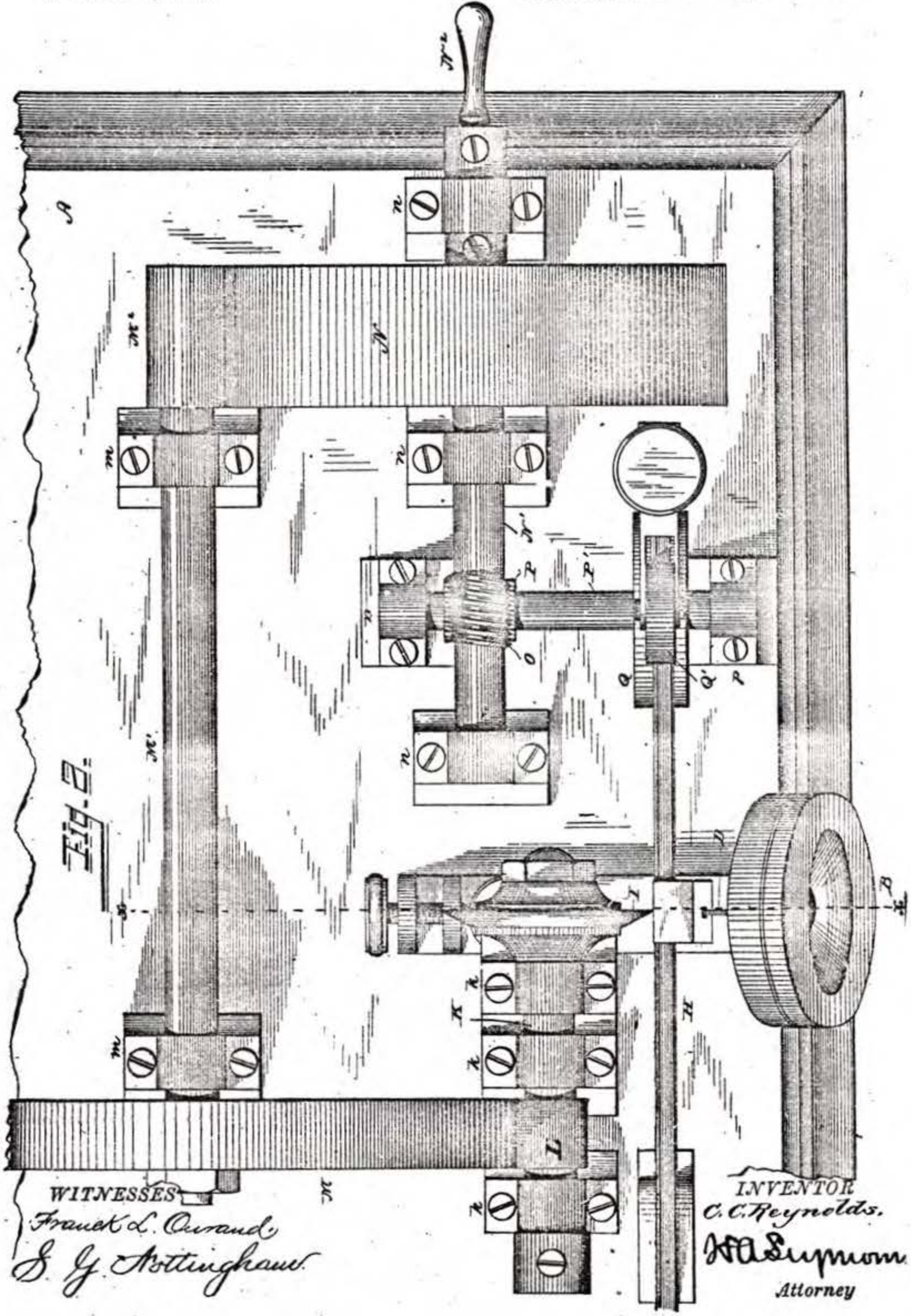
(No Model.) 5 Sheets—Sheet 2.

# C. C. REYNOLDS.

## PHONOGRAPH.

No. 287,166. Patented Oct. 23, 1883.

**Fig. 2.**



WITNESSES

Franck L. Ourand

S. G. Nottingham

INVENTOR

C. C. Reynolds.

H. A. Seymour

Attorney

(No Model.) 5 Sheets—Sheet

# C. C. REYNOLDS.

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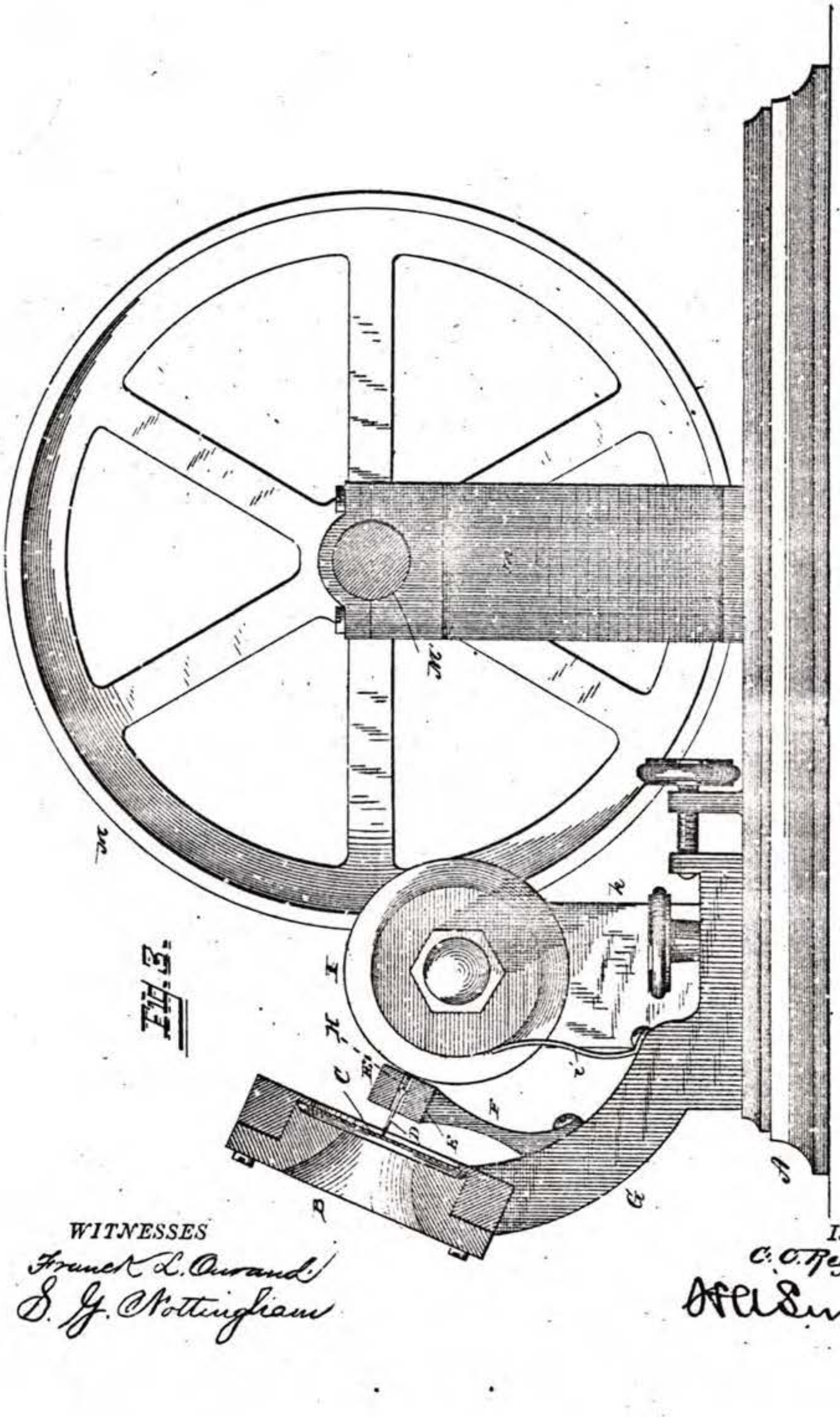


Fig. 3.

WITNESSES

Franck L. Ourand.

S. G. Nottingham

INVENTOR

C. C. Reynolds.

H A Seymour

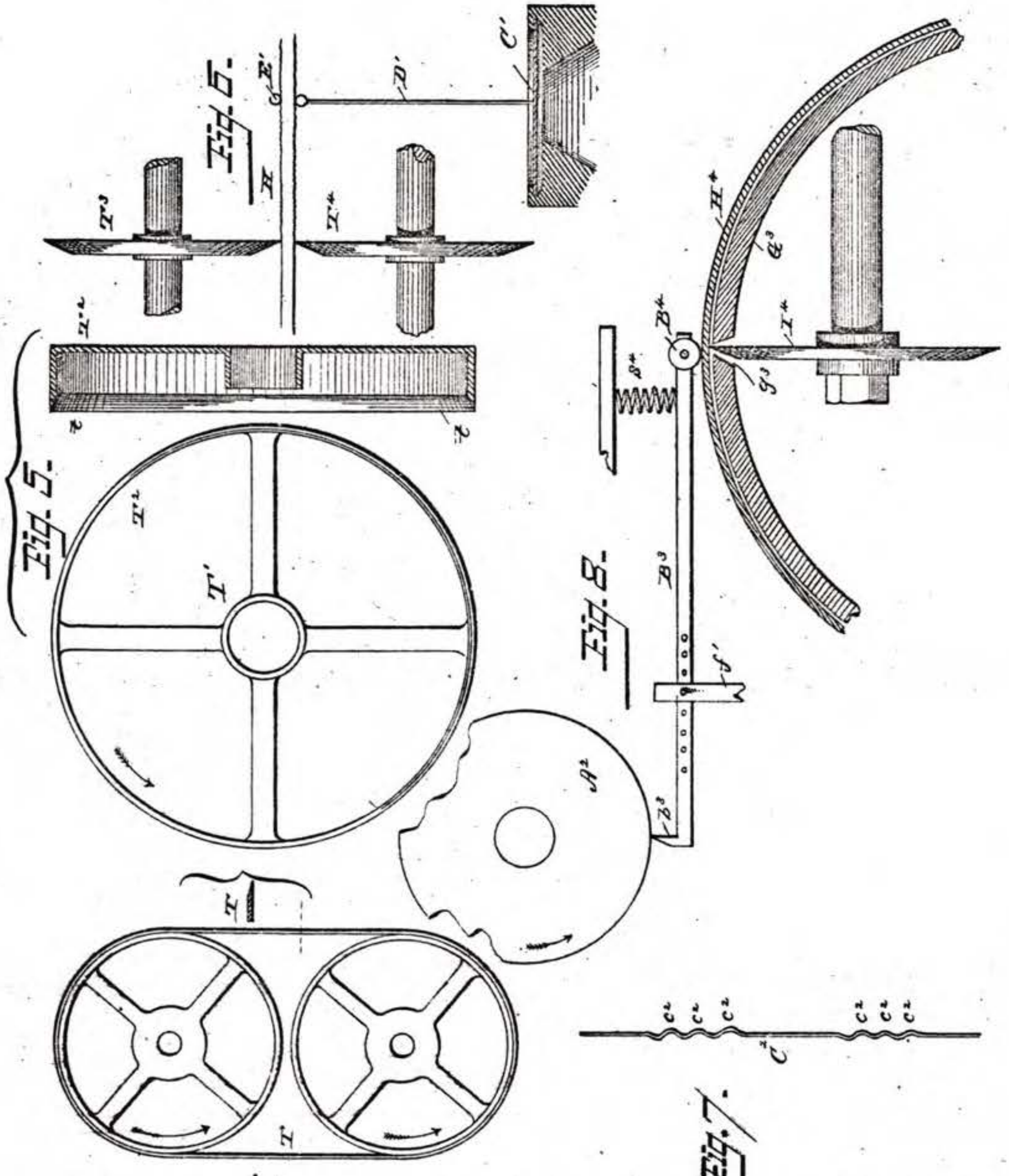
Attorney

(No Model.) 5 Sheets—Sheet 4.

## C. C. REYNOLDS.

### PHONOGRAPH.

No. 287,166. Patented Oct. 23, 1883.



WITNESSES
Franck L. Ourand.
S. G. Nottingham

INVENTOR
C. C. Reynolds.
H. A. Seymour
Attorney.

(No Model.) 5 Sheets—Sheet 5.

# C. C. REYNOLDS.

## PHONOGRAPH.

No. 287,166. Patented Oct. 23, 1883.

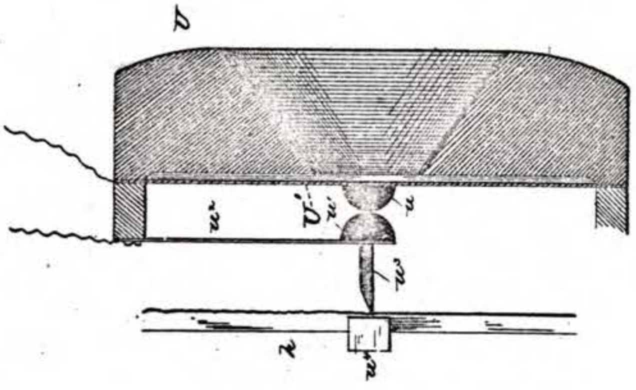


Fig. 9.

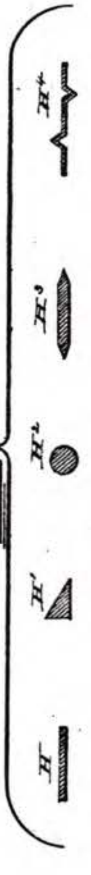


Fig. 11.

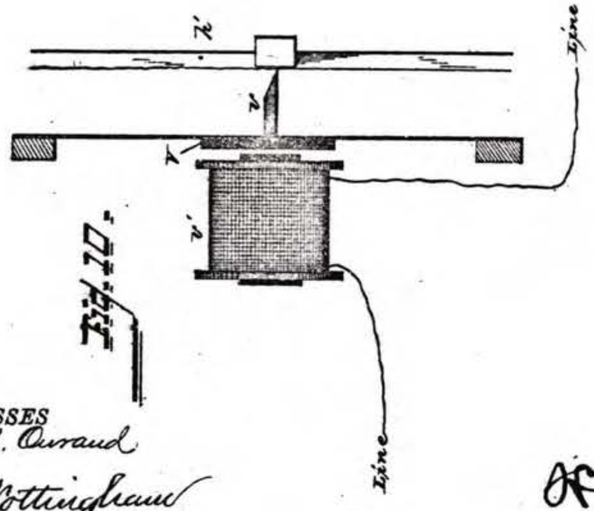


Fig. 10.

WITNESSES
Franck L. Ourand
S. G. Nottingham

INVENTOR
C. C. Reynolds.
H. A. Seymour.
Attorney

# UNITED STATES PATENT OFFICE.

CHRISTOPHER C. REYNOLDS, OF PRESCOTT, ARIZONA TERRITORY.

## PHONOGRAPH.

SPECIFICATION forming part of Letters Patent No. 287,166, dated October 23, 1883.

Application filed May 28, 1883. (No model.)

*To all whom it may concern:*

Be it known that I, CHRISTOPHER C. REYNOLDS, of Prescott, in the county of Yavapai and Territory of Arizona, have invented certain new and useful Improvements in Phonographic Instruments; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in phonographic instruments, and methods by which are produced permanent records of sounds in such form that the sounds may be reproduced through the instrumentality of the records.

Instruments of this class as heretofore constructed have produced the sound-record by embossing or indenting a sheet of tin-foil or similar thin and pliable material, which is supported upon a revolving cylinder or plate to receive the action of a recording-stylus, which is forced directly against the sheet by a diaphragm vibrating in response to sounds, the said cylinder or plate being grooved spirally in order to permit the record-sheet to be forced into the groove to raise the record on one side of the sheet, while it is sunken or indented on the other side. The disadvantages of such an instrument are as follows: First, its capacity for continuous recording is limited by the dimensions of the cylinder or plate which supports the record-sheet; second, removing the sheet from its supporting plate or cylinder destroys the perfection of the record, as the embossing becomes more or less disarranged or obliterated as the thin and soft sheet is subjected to the handling and bending necessarily incident to its removal; third, the embossing is so delicate and fragile that it is distorted by the action of a stylus, with which it is moved in contact for the purpose of reproducing the sounds, and consequently the reproduction is not exact; and, fourth, the resistance which the record-sheet opposes to the recording-stylus prevents the diaphragm from having an amplitude of vibration commensurate with the force of the sound-waves projected against it, and therefore the reproduction will not have the volume or loudness of the original sounds.

It is the object of my invention to provide a phonographic apparatus which is not subject to the disadvantages above enumerated; and to this end it consists in a new method and certain novel constructions and combinations of devices, which will be clearly understood from the following particular description, in connection with the accompanying drawings, in which—

Figure 1 is a side elevation of a phonograph constructed according to my invention. Fig. 2 is a top view thereof. Fig. 3 is a section on the line *x x*, Figs. 1 and 2. Fig. 4 is a view in elevation and diametric section of a modified form of the record-cutter. Fig. 5 is a view in elevation and section of another modification of the record-cutter. Fig. 6 is a plan view of a portion of an instrument adapted to cut the record on both sides of the record-strip. Fig. 7 is a diametric section of a form of diaphragm adapted for use in my improved phonograph. Fig. 8 is a diagram illustrating the construction of an instrument for copying and amplifying an original record made by the old forms of instruments. Fig. 9 is a section of a portion of a telephone-transmitter adapted for transmitting sounds in connection with a record-strip produced by my improved instrument. Fig. 10 is a fragmentary section of another form of telephonic transmitter adapted for operation by the record-strip; and Fig. 11 is a view in cross-section of various forms of strips which may be used to receive the record.

In the drawings, the letter A indicates a base-board, upon which the various parts of my phonograph are mounted.

B is a mouth-piece, in which is secured a diaphragm, C, in the manner usual in such instruments, and from the center of this diaphragm projects a stem, D, corresponding to the stylus of the ordinary phonograph. The outer end of this stylus plays between two guides, E E, supported by an arm, F, which projects from the adjustable standard G, which carries the mouth-piece. These guides E are arranged to receive between them the traveling record-strip H, which is guided across the edge of a rotary cutter-plate, I, which is carried by a shaft, K, mounted in bearings at the tops of standards *k*, rising from the base-board. Said shaft has also fixed upon it a friction-wheel, L, which is driven by a larger friction-wheel, M, carried by a shaft, M′, supported by standards m, and carrying at its opposite end a friction-pinion, $M^2$, which is driven by a main driving friction-wheel, N, carried by a shaft, N′, which rotates in bearings on standards n. This shaft N′ is provided with a worm-gear, o, which meshes with a tooth-pinion, P, mounted on a transverse shaft, P′, supported by standards p, and having fixed upon it a friction feed-wheel, Q, over which passes the record-strip H, said strip being held properly in contact with the periphery of said feed-wheel by means of an adjustable pressure-wheel, Q′.

Near the opposite end of the base-board from the feed-wheel Q, and beyond the guides E E, is a guide, R, which also supports the record-strip and directs it properly between the guides E E. The record-strip, as shown in Fig. 1, is oblong in cross-section, as shown also at H in Fig. 11. It is to be made of a metal which will well support itself and resist ordinary wear—such, for instance, as copper, brass, iron, or soft untempered steel. The dimensions of the strip may be varied; but in practice a strip from one-eighth to three-sixteenths of an inch wide, and from one thirty-second to one-sixteenth of an inch thick, will be found to be of convenient size for general use. It is designed to cut into the edge of this strip indentations or notches corresponding to the record-indentation of the ordinary phonograph, this indented edge to be drawn in contact with a stylus connected with a reproducing-diaphragm in the ordinary manner, and thus reproducing the recorded sounds.

The operation of the apparatus as shown in the drawings will be readily understood. The record-strip H is first passed through the guide R, and then between the guides E in contact with the stem D, and on over the feed-wheel Q and under the pressure-wheel. The strip may be delivered from a suitable reel, (not shown in the drawings,) and after leaving the feed-wheel may be wound upon another reel, or disposed of in any desired manner. The guides and guide-wheel are so arranged that the edge of the strip H will lightly touch the edge of the cutter-wheel I. Now, when the shaft N′ is turned by its crank $N^2$, motion is transmitted through the friction-wheel N, pinion $M^2$, shaft M′, friction-wheel M, pinion L, and shaft K to the cutter-wheel I, which has a knife-edge of tempered steel. The relation of the devices for transmitting motion is such that even when the shaft N′ is turned comparatively slowly, a very rapid rotary motion will be given to the cutter-wheel. At the same time that motion is being transmitted to the cutter-wheel from shaft N′ said shaft also transmits motion through the worm o, pinion P, and shaft P′ to the feed-wheel Q in the direction indicated by the arrow, and thus, while the cutter-wheel is rotating, the record-strip H is drawn across its edge, and if, while this operation is going on, sounds are produced in front of the diaphragm C, said diaphragm will be caused to vibrate and operate the stem D to drive the record-strip against the cutter-wheel I with a range and force of movement corresponding to the air-vibrations set up by the sounds, and the cutter-wheel will consequently cut notches or indentations into the edge of the record-strip which represent an exact record of such sounds.

It will be readily seen that the cutter-wheel opposes but a slight resistance to the movement of the record-strip, as it is so sharp and its movements so rapid that the edge of the record-strip is easily and rapidly cut away when it is passed against the cutter, even though the strip be of a material and bulk which enable it to sustain a considerable handling and friction when used for reproducing sounds, by drawing its indented edge in contact with a stylus arranged to operate a diaphragm.

It will also be seen that a record of indefinite length may be produced, or short records may be produced in rapid succession, by feeding strips of the desired length to the cutter-wheel.

In order to keep the cutter-wheel clear of particles of metal which might adhere to it, a light spring, i, is arranged to bear against each side of said wheel, so as to scrape off the adhering cuttings. This is a great advantage over the old forms of phonographs, in which, as is well known, the extent of the record is limited by the dimensions of the plate or cylinder which supports the foil-strip.

The sounds reproduced by a record-strip formed by my machine approach more nearly the original sounds in loudness and volume than do the sounds reproduced by the old forms of records, as by my improvement so little resistance is opposed to the movement of the strip that the diaphragm has a vibration much more nearly commensurate with the sounds projected against it than is possible when the record must be produced entirely by the force of movement of the diaphragm in driving the stylus against a record-sheet.

The record-cutter need not be limited in form to a simple rotary knife-edged disk. I have contemplated using a cutter operating after the manner of a band-saw, as shown in Fig. 4, in which the letter T indicates a steel band having one of its lateral edges beveled and sharpened to act upon the record-strip.

I may also use a rim-wheel cutter, as shown in Fig. 5, in which the letter T′ indicates a spoked wheel having a rim, $T^2$, one of the lateral edges of which is beveled to a knife-edge, as shown at t.

I may also form the cutter-wheel with cutting-faces, similar to a fine file, to facilitate its cutting and smoothing of the edges of the notches; but such file-faces are not essential.

In Fig. 6 is illustrated a portion of an instrument having two cutters, $T^3$ and $T^4$, between the edges of which the record-strip H passes, said strip passing also through a guide-eye, $E^5$, connected to the stem $D'$, projecting from a diaphragm, $C^5$. In an instrument thus constructed the complete vibration of the diaphragm in both directions is utilized for producing the record, complementary portions of the record being cut in opposite edges of the strip. If such a strip be drawn between a fixed stylus and a movable stylus attached to a reproducing-diaphragm, it is obvious that the two edges of the strip will co operate in giving the diaphragm vibrations of extensive amplitude, and thus the reproduction of sounds will be very nearly as loud as the original.

In order to give the recording-diaphragm a capacity for free and prompt vibration, I have preferred to form said diaphragm with concentric corrugations, similar to the diaphragms of pressure-gages used for indicating steam-pressure. Such a diaphragm is shown in section in Fig. 7, in which $C^6$ indicates the diaphragm, and $c^6$ $c^6$ $c^6$ the corrugations. I have found such a diaphragm very sensitive and efficient in response to sounds.

The essential principle of my improvement may be utilized for reproducing, in durable and amplified form, the fragile records made by the old styles of phonographs. In the diagram Fig. 8 is illustrated the embodiment of my improvement in an apparatus for this purpose. The letter $A^3$ designates a cylinder which may be arranged to travel longitudinally, as well as to rotate in a manner similar to that of the cylinder of the old styles of phonographs. $B^3$ is a lever provided with a stylus, $b^3$, for acting upon an old record-sheet, which may be placed upon this cylinder. Said lever has an adjustable fulcrum, $f'$, and at the end opposite the stylus carries a pressure-roller, $B^4$. The letter $G^3$ indicates a supporting-table, against which the roller $B^4$ will be pressed by a spring, $s^4$. This table has an opening at $g^3$, through which plays the edge of a cutter-wheel, $I^4$, which may be given a rotary motion by any suitable means. The letter $H^4$ indicates a record-strip, which may be drawn under the wheel $B^4$ and across the edge of the cutter-wheel, and if, while the said strip is so drawn, the cylinder $A^3$ be rotated, the record-strip thereon will vibrate the lever $B^3$ and cause the roller $B^4$ to press the record-strip in contact with the edge of the cutter-wheel with a varying pressure corresponding to the indentations of the record-sheet, which will be thus copied and given the form of a continuous strip. It is obvious that the copy may be much amplified by regulating the position of the adjustable fulcrum, so that the wheel $B^4$ will be carried by a long arm having any desired proportion to a shorter arm of the lever $B^3$, which carries the stylus.

The record-strips produced by my improved machine are peculiarly applicable for use in transmitting messages by telephone—as, for instance, should a person desiring to transmit a telephonic message be unable to send his message immediately and have no time to wait, he may prepare a record or message strip by one of my phonographs, and the telephonic operator may use the strip in transmitting the message at a future time, or in its regular order with other messages waiting until the line can be used.

In Fig. 9 the letter U indicates a portion of a telephonic transmitter which may be used for transmitting messages either directly by the voice or through the instrumentality of a record-strip. The letter $U'$ indicates a diaphragm arranged in the mouth-piece in the usual manner, and provided on its rear surface with a carbon button, $u$, which is in contact with another carbon button, $u'$, carried by a spring, $u^2$. The carbon button $u'$ has projecting from its rear side a stylus, $u^3$, behind which is a guide, $u^4$, for a record-strip, $h$. The diaphragm U and the spring $u^2$ are supposed to be connected with the primary circuit of an induction-coil in the usual manner. It is not necessary to explain the manner of transmitting directly by the voice; but in case a record-strip, as shown at $h$, is to be used, such strip is drawn through the guide $u^4$, with its indented or record edge in contact with the tip of the stylus $u^3$, and will vibrate said stylus longitudinally, so that the pressure between the buttons $u$ and $u'$ will be varied in correspondence with the indentations of the strip, and thus the current varied in a manner to transmit the message represented by the strip.

In Fig. 10 is illustrated another form of transmitter, in which an armature, V, is provided with a stylus, $v$, to receive the action of a record-strip, as shown at $h'$, so that said armature will be vibrated in front of the core of an electro-magnet, $V'$, and induced undulatory currents be thus set up in the coil of the magnet in correspondence with the record, such induced currents traversing a line-wire and acting upon a receiver in the usual manner.

As before stated, the record-strip may be given various forms in cross-section—such, for instance, as illustrated in Fig. 11. H indicates the flat strip, oblong in cross-section, and with rectangular edges. $H'$ is a strip triangular in cross-section. $H^2$ is a round strip. $H^3$ is a flat strip having double-beveled edges, and $H^4$ is a strip having sharp ribs to receive the action of the cutter. These strips may be made of any of the metals hereinbefore mentioned, or any durable material which will withstand the frictional wear and handling incident to their use. It will sometimes be found of advantage to make the record-strip of soft steel and temper or harden it after the record has been cut. Such a strip will obviously be extremely durable.

Having now fully described my invention and explained the operation thereof, I wish it to be understood that I do not confine myself to the precise details of construction shown in my drawings and heretofore particularly described, but may vary the same in any manner for the better carrying out the essential principles of my improvement.

What I claim is—

1. In a phonograph, the combination, with means for moving a record-strip by sound, of one or more moving cutters arranged to act upon said strip, substantially as described, and for the purpose set forth.

2. In a phonograph, the combination, with the diaphragm and the moving cutter arranged to act upon a strip vibrated by said diaphragm, of feeding mechanism adapted to move a record-strip across the edge of the cutter, substantially as described.

3. In a phonograph, the combination, with the diaphragm and two moving cutters, of feeding mechanism adapted to move a continuous strip between said cutters, and intermediate devices for transmitting a vibratory motion to said strip from the diaphragm, so that the opposite edges of said strip will be alternately pressed against the cutters, respectively.

4. A phonograph-record consisting of a metallic strip having record-indentations of varying character representing sound-wave caused by articulate speech cut through one or more of its edges, substantially as described.

5. The herein-described method of preparing phonographic records, the same consisting in vibrating a record-strip by sounds and causing said strip to be cut during and in proportion to its vibration by a cutting-instrument operated independently of the diaphragm, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

CHRISTOPHER COLUMBUS REYNOLDS.

Witnesses:
GEO. W. CURTIS,
WILLIAM WILKERSON.

(No Model.) 3 Sheets—Sheet 1.

# S. TAINTER.

## RECORDING AND REPRODUCING SOUNDS.

No. 341,287. Patented May 4, 1886.

Fig. 1.

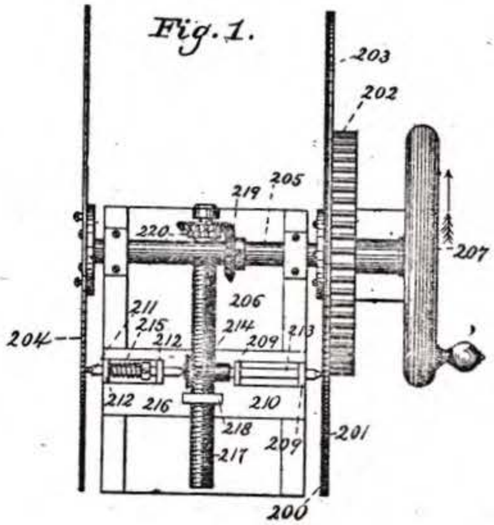


Fig. 2.

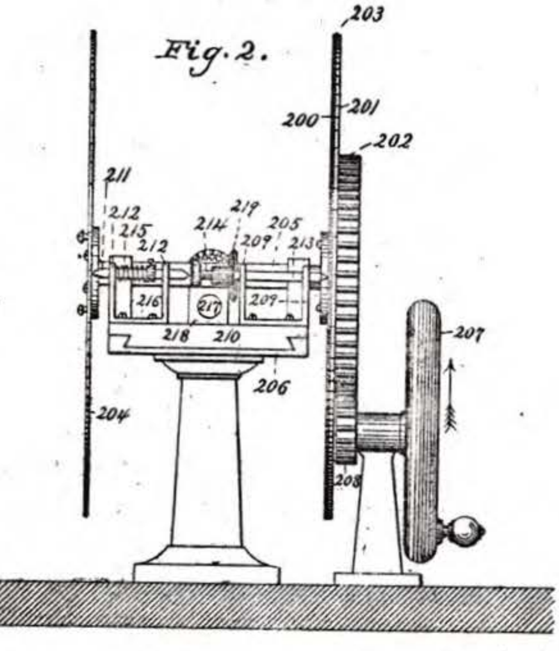


Fig. 1ª

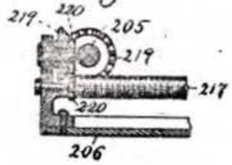
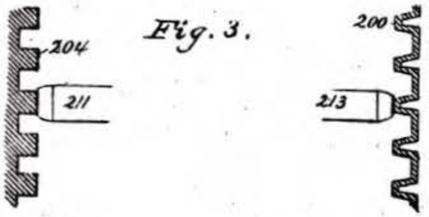


Fig. 3.



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(No Model.) 3 Sheets—Sheet 3.

# S. TAINTER.

## RECORDING AND REPRODUCING SOUNDS.

No. 341,287. Patented May 4, 1886.

Fig. 9.

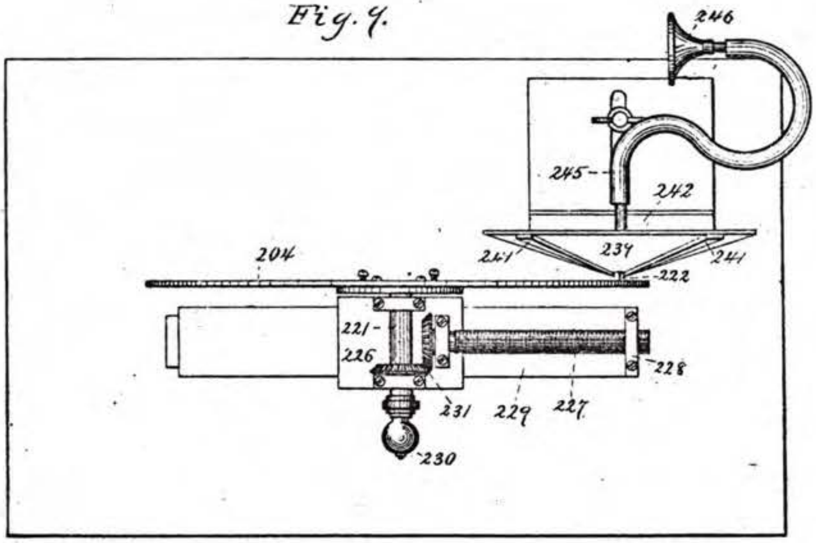


Fig. 10.

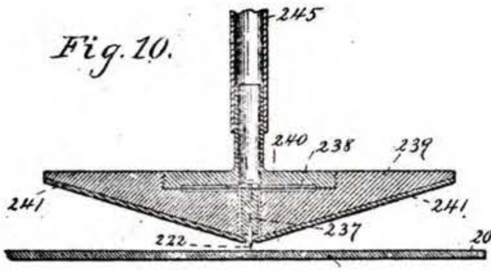


Fig. 11.

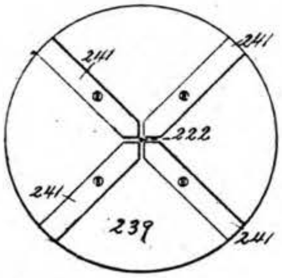
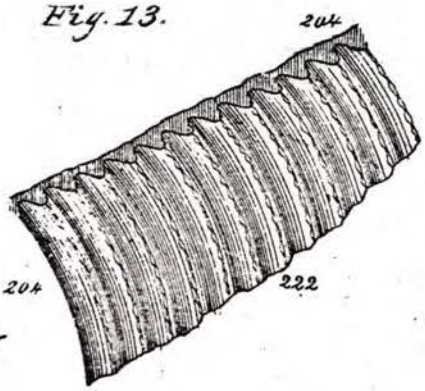


Fig. 13.



Witnesses.
Wm. Kicken, Jr.
John C Pasker

Inventor
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his attorney

—heet 3.

1886.

# UNITED STATES PATENT OFFICE.

### SUMNER TAINTER, OF WASHINGTON, DISTRICT OF COLUMBIA.

## RECORDING AND REPRODUCING SOUNDS.

SPECIFICATION forming part of Letters Patent No. 341,287, dated May 4, 1886.

Application filed August 29, 1885. Serial No. 175,810. (No model.)

*To all whom it may concern:*

Be it known that I, SUMNER TAINTER, of Washington, in the District of Columbia, have invented a new and useful Improvement in Recording and Reproducing Sounds, which improvement is fully set forth in the following specification.

This invention relates to the reproduction, through the action of magnetism, of sounds by means of records in solid substances. For this purpose it is necessary, first, to prepare the record in a suitable material, (magnetic or diamagnetic.) The material specially adapted to the purpose is of course iron, (using the word broadly as including steel and various grades of iron.) Owing to the hardness of iron, it is not practical to cut the record directly therein by means of a cutting-style vibrated by the action of the voice, as described in application for Letters Patent of the United States of Chichester A. Bell and Sumner Tainter, filed June 25, 1885, and officially numbered 170,044. The same property would interfere with the preparation of records by the Edison method of indenting, which method is, moreover, inferior to the cutting method in sharpness and in compactness of the record.

According to the present invention the record is first cut in a comparatively soft material, (preferably wax or a waxy composition,) and from an electrotype of this or from other suitable record a copy is made in iron or other suitable material by means of a graver or cutting-style which is actuated by the record to be copied. The wax record would not ordinarily have sufficient strength to withstand the pressure to which it would be subjected in cutting the metal, and for this reason the electrotype is made.

Another method of preparing a magnetic record would be to plate a thin film of iron upon an electrotype taken from the wax or other suitable record.

Having prepared a suitable magnetic record, it is necessary to provide means sufficiently sensitive to respond to the record. Heretofore it has been proposed to attach a magnetized needle to a diaphragm and to support the latter so that the point of the needle is in close proximity to the record, (which it was proposed to form by indenting an iron foil.) In the present invention, in addition to the means before stated for improving the quality of the record, means are provided for increasing the sensitiveness of the receiving-instrument.

Instead of depending wholly upon the permanent magnetism of the needle, one or more inducing-magnets are employed, and the record itself is or may be rendered magnetic by induction or permanently. It is also found that excellent results can be obtained by inducing currents in an electric circuit which includes a receiving-telephone. For this purpose a coil should surround the reproducing-needle. Good results have also been secured by means of mechanical receiving devices without the introduction of electric currents.

Instead of inducing magneto-currents in the receiving-circuit, an electric current can be undulated by variations in resistance produced by the vibrations of the needle.

In the accompanying drawings, Figures 1 and 2 are a plan and a front elevation, respectively, of the apparatus for engraving the iron record; Fig. $1^a$, a partial view in vertical section, and Fig. 3 a diagram illustrating in plan and horizontal section the forms of the copying-tools and of the electrotype and the iron tablet on which the record is to be made. Figs. 4, 5, 6, 7, and 8 are partial views in elevation of different forms of magneto-electric reproducers constructed in accordance with the invention. Fig. 9 is a plan of a magneto-mechanical reproducer, also constructed in accordance with the invention, or with parts thereof; Figs. 10 and 11, detail views showing in section and front elevation, respectively the principal parts of the reproducer. Fig. 12 is a view showing an arrangement in which the magnetic reproducing-needle is connected with the electrodes of a contact-telephone; and Fig. 13 is an illustration of an iron record in perspective and section, the point of the reproducing-needle being shown in position.

In preparing the iron record according to the best mode to me known, the record is first cut in wax or a waxy composition, as described in the before-mentioned application; but the cutting-style, which is attached to a vibratory diaphragm, has preferably a flat or chisel-like point, so that the recording-tablet is engraved with a spiral groove of trapezoidal cross-section, the elevations and depressions at the bottom of the groove representing the forms of the sound-waves which act successively upon the diaphragm of the recording-instrument. As the recording-instrument, tablet, and accessories are fully set out in the before-mentioned application, it is considered unnecessary to repeat them here. From this original wax record an electrotype is taken in copper by known methods—that is to say, the surface of the wax is coated with blacklead, or is otherwise rendered conductive, and is then placed in an electro-plating cell. The electrotype, when of sufficient thickness, say twenty-five one-thousandths of an inch, (0.″025,) is removed from the wax and mounted on a backing, with a thin layer of plaster interposed. As shown in Figs. 1, 2, and 3, the electrotype 200 is mounted on a metal disk, 201, provided with a gear-wheel, 202, at the back. Ground plaster-of-paris is mixed to a thick emulsion with water and applied between the electrotype and the supporting-disk, which are then pressed together until the plaster hardens. The layer of plaster is indicated at 203. The electrotype is of course the counterpart of the original wax phonogram, with the elevations and depressions at the top of a spiral ridge, instead of at the bottom of a groove.

In order to prepare the iron disk 204 for engraving the record thereon a spiral groove is turned in the face of said disk, forming a spiral ridge of the cross-section shown in Fig. 3. The iron disk 204 and the electrotype 200, with its backing 201, are mounted at opposite ends of the shaft 205, being, as shown, bolted to a flange thereon. The shaft 205 is journaled in bearings of the frame 206. It and the disks attached thereto are revolved by means of a crank-wheel, 207, on an independent short shaft, which carries a pinion, 208, engaging the gear-wheel 202 on the disk 201. The slide 210, mounted in ways of the frame 206, carries the graver or cutting-tool 211, it being mounted in guides 212, so that it can be moved toward and away from the iron disk or tablet 204. It is moved toward the iron disk by the electrotype 200, which rubs against the end of the follower 213, the latter being in the form of a square rod sliding in guides 209 on the slide 210. The screw 214 is tapped into the enlarged end of the follower, and the inner or right-hand end of the cutting-tool rests against the end of the screw. A spiral compression-spring, 215, interposed between a collar, 216, on the cutting-tool and left-hand guide 212, tends to press the cutting-tool against the screw 214, and consequently to hold the follower 213 in contact with the electrotype. By turning the screw 214 the cutting-tool can be adjusted to cut to the desired depth. It is a flat-nose tool, and has its point opposite and in contact with the ridge on the iron disk, as shown in Fig. 3. The outer (right-hand) end of the follower is beveled on the four sides, leaving a rounded edge, as shown in Fig. 3, which makes contact with the ridge on the electrotype. The elevations on the electrotype 209 move the follower 213 and cutting-tool 211, so as to take a chip of corresponding depth from the ridge on the iron disk 204. The depressions on the electrotype allow the spring 215 to move the follower and cutting-tool to the right, so that a smaller chip or none at all is taken from the iron ridge. Thus the counterpart of the elevations and depressions on the electrotype is formed on the iron disk. The record engraved on the latter, therefore, is like the original wax record from which the electrotype was taken.

The slide 210 is engaged by a screw 217, which revolves in a bearing in the frame 206, so constructed as to prevent endwise motion of the screw. The screw is tapped through an ear, 218, on the slide. It is connected with the shaft 205 by the bevel-gears 219 and spur-gears 220. Thus at each revolution of the disks the slide is drawn forward a distance equal to the pitch of the spiral ridges on the electrotype and iron disk.

If the iron be too hard, or if for other reason it is not desired for it to be cut to the full depth at one operation, the cutting-tool can be adjusted by the screw 214 first to cut shallow, and then, when the parts have been returned, adjusting it and causing it to cut deeper, and so on until the desired depth is reached.

Having obtained the engraved magnetic tablet, it is mounted on the shaft 221 of a reproducing-instrument. As shown in Fig. 4, the reproducing-needle 222 is mounted on one pole of a horseshoe-magnet, 223, the other pole of which is placed directly opposite, the magnetic record intervening. A pole-piece, 233, brings the pole close to the back of the tablet or disk 204. Thus the needle and the record or tablet are both magnetized by the induction of the magnet. From the proximity of the poles the intensity of the field is very considerable. The needle (which may be of any suitable size and shape, but should terminate in a point or edge, and be either of soft iron or steel) is surrounded by a bobbin, 224, of fine insulated wire. The telephone 225 (shown as the hand-telephone in common use) is included in circuit. The reproducing-needle has its point opposite the ridge on the tablet and in as close proximity thereto as possible without touching. Fig. 13 shows the position, the record being formed by elevations and depressions on the top of the ridges, which are rounded instead of square, as in Fig. 3. As the tablet or iron disk 204 is revolved, the elevations and depressions on the ridge successively come opposite the needle-point and produce changes in the magnetic field, which in turn induce currents in the bobbin 224 and telephone 225. Sounds corresponding to these changes, and consequently also to the record on the iron disk or tablet, are emitted by the telephone.

Any ordinary or suitable mechanism may be employed for causing the needle to follow the spiral ridge or record on the tablet or disk

204—as, for example, that shown in Fig. 9, wherein the shaft 221 is mounted on a slide, 226, which is connected by the screw 227 with an ear, 228, on the frame 229, (the screw revolving in a bearing on the slide, and being tapped through the ear 228,) so that as the shaft 221 is turned by the crank 230 the screw 227 is revolved by the bevel-gears 231, and the disk 204 is given a translatory as well as a rotary motion.

In Fig. 5, instead of having the tablet or disk interposed between the poles of the magnet, both the poles are opposite the face of the tablet. In Fig. 6 the arrangement is similar, except that the side instead of the ends of the magnet is turned toward the tablet.

In Figs. 7 and 8 the tablet is shown as a cylinder, 234. The magnet in Fig. 7 has both poles on the same side of the cylinder, while in Fig. 8 it spans the same. The surface of the cylinder should be engraved the same as described for the disk 204, and the cylinder can be operated by the well-known means employed in the ordinary Edison phonograph, or by other suitable mechanism.

In the arrangement shown in Figs. 9, 10, and 11 the needle 222 is set in a holder, 237, of non-magnetic material, (preferably hard rubber,) which is attached to the center of a thin diaphragm, 238, (see Fig. 10,) which is confined at the edges by and between the block 239 and screw-plate 240. A series of four bar-magnets, 241, are secured on the face of block 239, with their like poles in proximity to the needle 222, so as to magnetize the same, or to increase its magnetism by induction. The ends of the magnets are pointed, as shown in Fig. 11. The block 239 is mounted upon a bracket, 242, which is adjustably secured in place by means of a screw passing through a slot in the base of the bracket and engaged by a set-nut. The screw-plate 240 is perforated, and the round conveying-tube 245, provided with an ear-piece, 246, is in communication with the space behind the diaphragm through the perforation. The bracket 242 having been adjusted to bring the needle-point in the desired proximity to the tablet or disk 204, the latter is revolved. The variations in the surface of the tablet cause variations in the magnetic field, and produce a varying attraction of the magnetized needle, and consequently throw the diaphragm 238 into vibrations, which in turn are communicated to the air in the tube 245, and by it conveyed to the ear of the listener.

In Fig. 12 the varying attraction between the needle and the tablet produces variations in pressure between the electrodes 248 of a microphone or contact-telephone, and thereby produce undulations in the current passing from one electrode to the other. These electrical undulations are converted into sound-waves by an ordinary receiving-telephone.

It is evident that modifications may be made in details without departing from the spirit of the invention, and parts of the invention may be used separately. The preparation of an engraved iron record and the magnetic reproduction of sounds from such engraved record constitutes an important feature of the invention; yet as certain features in the reproducing means described are new in and of themselves it is not designed to limit the invention to the use of such means in combination with the engraved record. In like manner the engraved iron record is believed to be new in and of itself; also, the means for transferring from one tablet to another by means of a cutting-tool, although designed expressly for the production of engraved iron records, are believed to possess novelty, irrespective of the nature of the material used.

Having now fully described the said invention and the manner of carrying the same into effect, what I claim is—

1. The improvement in the reproduction of sounds by records in solid substances, consisting in engaving or cutting the record in magnetic material, causing by means of such record corresponding variations in the field of a magnetized needle, and converting the magnetic variations into sound-waves, substantially as described.

2. The method of producing a magnetic record by first cutting the record in a soft material—such as wax—and then producing from such original a copy in the magnetic material, substantially as described.

3. The method of producing an engraved record in magnetic material by preparing a record in a softer material, and then causing said record or a copy of the same to impress movements corresponding to sound-vibrations upon a cutting-tool in contact with the said magnetic material, substantially as described.

4. The method of copying sound-records by causing the record which is to be copied to impress movements corresponding to the recorded sound-waves upon a cutting-tool, and thereby engraving or cutting out a similar record in the surface of a suitable tablet, substantially as described.

5. The method of reproducing sounds from magnetic records by causing said records to produce changes in the field of a magnetized needle, and thereby inducing electric currents in a coil in said field, and converting said currents into sound-waves, substantially as described.

6. An engraved sound-record in magnetic material, substantially as described.

7. A sound-record in magnetic material having a spiral ridge, the irregularities constituting the record being formed in the top of the ridge, substantially as described.

8. A tablet of magnetic material having a spiral groove turned in the surface thereof, and a sound-record formed in the top of the ridge between the convolutions of the groove, substantially as described.

9. The combination, with a sound-record in magnetic material, of a magnet or magnets and

a magnetic reproducing-needle in the field of said magnet or magnets, substantially as described.

10. The combination, with a magnetized sound-record, of a magnetic reproducing-needle, said record being magnetized independently of any magnetism induced therein by the needle, substantially as described.

11. The combination, with a magnetic record, the magnetic reproducing-needle, and the inducing magnet or magnets, substantially as described.

12. The combination, with a magnetic record, of a magnetized reproducing-needle, a bobbin of insulated wire in the field of said needle, and a telephone-circuit including the bobbin, substantially as described.

13. The combination, with an engraved record in magnetic material, of the magnetized reproducing-needle, substantially as described.

14. The combination, with a tablet having a record formed therein and a tablet for receiving a record, of a follower having a fine though blunt edge for rubbing over the record, a non-rotating cutter movable with said follower for engraving the record in the second tablet, and mechanism for revolving said tablets and causing the follower to follow the record, and the cutter to trace a spiral line upon the second tablet, substantially as described.

15. The combination, with the two tablets and the operating mechanism, of the follower having a fine though blunt edge for rubbing over the record, the spring for holding it against the record, the non-rotatory cutter, and the adjustable connection between the follower and the cutter to enable the depth of cut to be regulated, substantially as described.

16. The method of preparing sound records, consisting in first cutting the record in a soft material—such as wax—by the action of sound-waves upon a vibratory cutting-style, and then causing said wax record or a copy of the same to impress corresponding vibrational movements upon a graver or cutting-tool in contact with a record-tablet, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

SUMNER TAINTER.

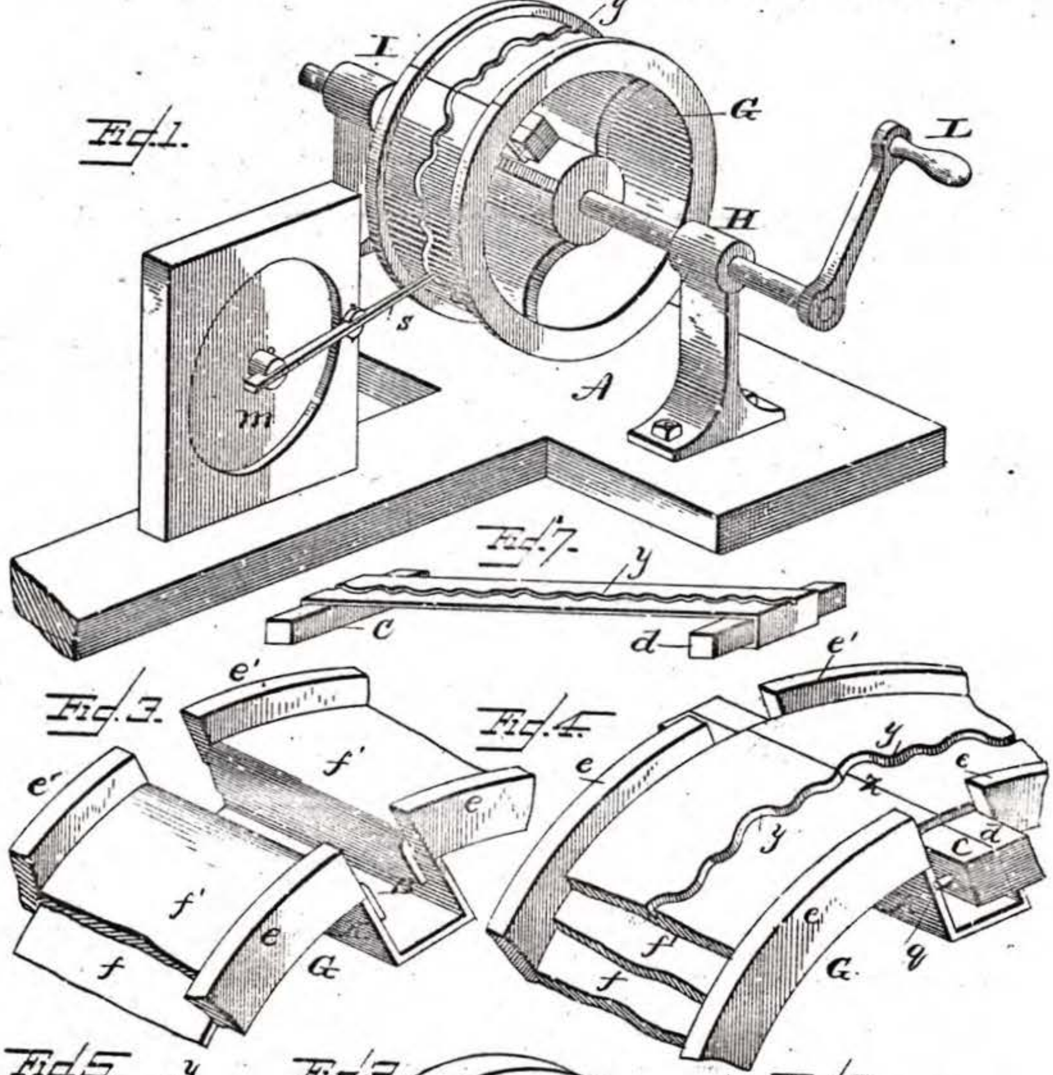
Witnesses:
PHILIP MAURO,
C. J. HEDRICK.

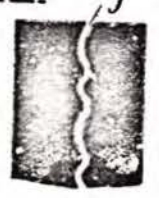
(No Model.)

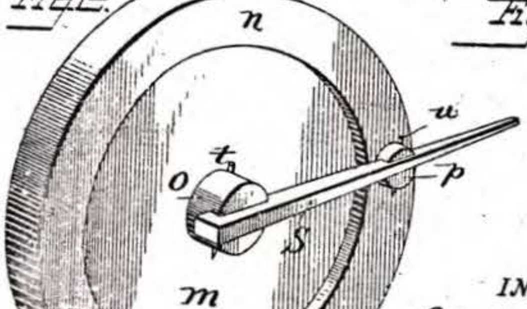
# E. BERLINER.

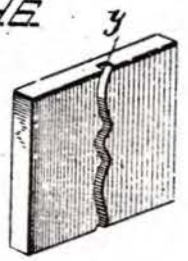
## GRAMOPHONE.

No. 372,786. Patented Nov. 8, 1887.









WITNESSES.

J. R. Coleman

Wm. E. Schoenborn

INVENTOR

Emile Berliner.

by Joseph Lyons

Attorney

# UNITED STATES PATENT OFFICE.

EMILE BERLINER, OF WASHINGTON, DISTRICT OF COLUMBIA.

## GRAMOPHONE.

SPECIFICATION forming part of Letters Patent No. 372,786, dated November 8, 1887.

Original application filed May 4, 1887, Serial No. 237,060. Divided and this application filed September 26, 1887. Serial No. 250,721. (No model.)

*To all whom it may concern:*

Be it known that I, EMILE BERLINER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Gramophones, of which the following is a specification.

This invention has reference to a novel method of and apparatus for recording and reproducing all kinds of sounds, including spoken words, and is designed to overcome the defects inherent in that art as now practiced and in the apparatus used therefor.

By the ordinary method of recording spoken words or other sounds for reproduction it is attempted to cause a stylus attached to a vibratory diaphragm to indent a traveling sheet of tin-foil or other like substance to a depth varying in accordance with the amplitudes of the sound-waves to be recorded. This attempt is necessarily more or less ineffective, for the reason that the force of a diaphragm vibrating under the impact of sound-waves is very weak, and that in the act of overcoming the resistance of the tin-foil or other material the vibrations of the diaphragm are not only weakened, but are also modified. Thus while the record contains as many undulations as the sounds which produce it, and in the same order of succession, the character of the recorded undulations is more or less different from those of the sounds uttered against the diaphragm. There is, then, a true record of the pitch, but a distorted record of the quality of the sounds obtained. The simple statement that the material upon which the record is made resists the movement of the diaphragm is not sufficient to explain the distortion of the character of the undulations, for if that resistance were uniform, or even proportional to the displacement of the stylus, the record would be simply weakened, but not distorted; but it is a fact that the resistance of any material to indentation increases faster than the depth of indentation, so that a vibration of greater amplitude of the stylus meets with a disproportionately greater resistance than a vibration of smaller amplitude. For this reason loud sounds are even less accurately recorded than faint sounds, and the individual voice of a loud speaker recorded and then reproduced by the phonograph cannot be recognized. With a view of overcoming this defect it has been attempted to engrave instead of indent a record of the vibrations of the diaphragm by employing a stylus shaped and operating like a chisel upon a suitably-prepared surface; but even in this case the disturbing causes above referred to are still present. In addition to this, if in the apparatus of the phonograph or graphophone type it is attempted to avoid the disturbing influence of the increase of resistance of the record-surface with the depth of indentation or cut as much as possible by primarily adjusting the stylus so as to touch the record-surface only lightly, then another disturbing influence is brought into existence by the fact that with such adjustment, when the diaphragm moves outwardly, the stylus will leave the record-surface entirely, so that part of each vibration will not be recorded at all. This is more particularly the case when loud sounds are recorded, and it manifests itself in the reproduction, which then yields quite unintelligible sounds.

It is the object of my invention to overcome these difficulties by recording spoken words or other sounds without perceptible friction between the recording-surface and the recording-stylus, and by maintaining the unavoidable friction uniform for all vibrations of the diaphragm. The record thus obtained, almost frictionless, I copy in a solid resisting material by any of the methods hereinafter described, and I employ such copy of the original record for the reproduction of the recorded sounds.

Instead of moving the recording-stylus at right angles to and against the record-surface, I cause the same to move under the influence of sound-waves parallel with and barely in contact with such surface, which latter is covered with a layer of any material that offers a minimum resistance to the action of a stylus operating to displace the same, all substantially in the manner of the well-known phonautograph by Leon Scott. All this will more fully appear from the following detailed description, in which reference is made to the accompanying drawings, which illustrate one of the numerous forms which my improved apparatus may assume, and in which—

Figure 1 is a perspective view of my recording and reproducing apparatus; Fig. 2, a like view of the recording and reproducing diaphragm with its stylus; Fig. 3, a similar view of a portion of the support for the record-surface; Fig. 4, the same view with the record-surface applied; Fig. 5, a plan view of a phonautographic record; Fig. 6, a perspective of a phonautographic record copied in solid resisting material; and Fig. 7, the copied record mounted, ready for application to the support.

The general arrangement of the parts is best illustrated in Fig. 1, in which a T-shaped base-plate, A, is shown, upon which two standards, H I, serving as journal-bearings for the shaft of drum G, are mounted. The drum G may be constructed with flanges *c c'*, which project beyond the cylinder-surface *f*, and from the edges of a gap, B, left upon the cylinder-surface extend the side walls of box K, as shown. A thin layer of felt or other yielding elastic substance is placed upon the cylinder-surface and is bent over the edges of the gap and secured to the side walls of the box K. This layer of elastic material is designed to serve as the support for the record-surface both in recording and reproducing.

For recording I employ a thin strip of paper, parchment, metal, or any other suitable substance, which is secured at both ends to bars *c d*, in the manner shown in Fig. 7, with reference to a copy of a record, and is then placed upon the elastic support *f'*, with the bars *c d* entering into but projecting at both ends beyond the box K, as illustrated in Figs. 1 and 4, with reference to an engraved copy of a record. Bolts *q*, passing through the projecting ends of bars *c d*, are employed to draw the record-strip tightly about the drum, and the length of the strip is such that the ends of the same meet as nearly as practicable upon a straight line, *z*. The record-sheet is then prepared to receive the record by covering its surface with a thin layer of any substance which is easily removed by the action of the recording-stylus. I may use lamp-black, which is deposited by placing a smoky flame under the record-strip and by slowly turning the drum until all parts of the strip are covered with the deposit. It is well known that a layer of lamp-black thus deposited, while it adheres well to the surface of a solid body, is nevertheless easily removed from the same. It requires only an exceedingly small force to draw a plainly-visible line upon such surface, owing to the fact that the spicules of carbon of which lamp-black is composed are only loosely superimposed upon each other, and are exceedingly light. All this has long since been recognized and utilized in the production of phonautographic records, and I take advantage of these facts in my improved method of recording and reproducing sounds.

The diaphragm *m* is mounted in a frame, *n*, with its plane at right angles to the axis of drum G. A post, O, is fixed to the center of the diaphragm, and a slot in said post receives one end of stylus S, which is pivoted in the post by a pin, *t*. The stylus extends over and beyond the frame, with its free end barely in contact with the record-surface, and is also pivotally supported in a slot in a post, *p*, secured to the frame by means of a pin, *u*, as shown in Figs. 1 and 2. It will now be seen that the stylus is in effect a lever having its fulcrum in the pin *u*, and that its free end can only move in lines practically parallel to the record-surface. If it is now desired to produce a record of sounds the drum is slowly and uniformly rotated by means of crank L, or by any other suitable means, and sounds are uttered or directed against the diaphragm. Under the impact of the sound-waves the diaphragm is set into vibrations, whereby the free end of the stylus is also caused to vibrate to the right and left of its normal position, removing at the same time an undulating line, *y*, of lamp-black from the record-surface, as indicated, greatly exaggerated, in Fig. 5. Since in this operation the stylus only penetrates a uniform layer of loosely-heaped carbon spicules and barely touches the record-surface, it is clear that the slight friction at the free end of the stylus will be uniform, whatever be the amplitude of vibration. Consequently the vibrations of the diaphragm will not be modified or changed by the reaction upon the same of a sensible and varying resistance, as is the case in all other mechanical sound-recorders.

Having thus obtained an accurate phonautographic record, the same may be fixed by applying a thin solution of varnish of any kind which dries very rapidly and which does not obliterate or change the record.

If in this process the deposit of lamp-black be made thick enough, the line drawn by the stylus would represent a groove of even depth, preserving all the characteristics of the sounds which produced it and which may be handled and touched with impunity. The latter is then removed from the drum and may be preserved any length of time without danger of its being disfigured. This record I then copy in solid resisting material, preferably metal, either by the purely mechanical process of engraving, or by chemical deposition, or by photo-engraving. I prefer the last-named process, which enables me to produce the most accurate copy of the original record in copper, nickel, or any other metal without in any way or manner affecting the original record. The copy thus obtained, which may be multiplied to any desired extent, is a grooved wave-line upon a strip or sheet of copper or other metal, as shown in Figs. 1, 4, 6, and 7, and for the reproduction of the recorded sounds it has the advantage over the ordinary records in tin-foil, wax, &c., that it is not sensibly attacked by the reproducing-stylus, and will stand an indefinite number of reproductions without the slightest variation in the accuracy and loudness of the reproduced sounds.

The copied record is fixed at both ends to the bars *c d*, as shown in Fig. 7, and is placed upon the elastic support $f'$ upon the drum in the same manner as has been described with reference to the original record-strip, and as is illustrated in Figs. 1 and 4. Care must be taken that the two ends of the undulatory groove $y$ meet exactly, as will be readily understood. This condition of the apparatus is shown in Fig. 1 with the engraven record upon the drum and the free end of the stylus entering the undulatory groove. If, now, the drum is rotated with uniform speed, the end of the stylus will be forced to follow the undulations of the groove $y$, and the diaphragm will be vibrated positively in both directions in strict accordance therewith, and will therefore reproduce the exact sounds which originally produced the record. This peculiarity of positive vibratory movement in both directions of the diaphragm is a feature which also distinguishes my method and my apparatus from others heretofore used.

In the phonograph and graphophone the end of the reproducing-stylus which bears upon the indented or engraved record has a vertical upward and downward movement. It is forced upwardly in a positive manner by riding over the elevated portion of the record, but its downward movement is effected solely by the elastic force of the diaphragm, which latter is always under tension. In my improved apparatus the stylus travels in a groove of even depth and is moved positively in both directions. It does not depend upon the elasticity of the diaphragm for its movement in one direction. This I consider to be an advantage, since by this method the whole movement of the diaphragm is positively controlled by the record, and is not affected or modified by the physical conditions of the diaphragm, which conditions necessarily vary from time to time and constitute some of the causes of imperfect reproduction of recorded sounds.

In practicing my method of recording and producing sounds I am not limited to the use of the identical apparatus herein shown and described. This apparatus may be varied indefinitely without seriously impairing its utility for the purposes in view. Thus it is not absolutely necessary that a diaphragm should be used for receiving the impact of sound-waves in recording and for remitting sounds in reproducing. Any sonorous body of whatever shape and material may be used in lieu of a diaphragm proper. The recording-surface need not be mounted upon a drum, but may be supported in any suitable manner upon a support of any description which is adapted to move the same under the stylus evenly and with approximately uniform speed. Nor do I confine myself to the use of lamp-black as a substratum for the phonautographic record, although I have found this substance to yield excellent results. Any other substance which adheres well to the support and may at the same time be removed from the same with a minimum force may be employed.

While I have found the process of photo-engraving to yield admirable copies of the phonautographic record, I do not mean to confine myself to this process to the exclusion of other processes for copying and multiplying the original record in solid resisting material; and it will be readily understood that the details of construction of my apparatus and the manipulations of the same may be greatly changed without departing from the fundamental idea of my invention.

I do not herein claim the apparatus shown and described, either generically or specifically, as a whole or in part, since the same forms the subject of another application for patent previously filed by me and of which this is a division.

What I do claim, and desire to secure by Letters Patent, is—

1. The method or process of recording and reproducing spoken words and other sounds, which consists in first drawing an undulatory line of even depth in a traveling layer of non-resisting material by and in accordance with sound-vibrations, then producing the record thus obtained in solid resisting material, and finally imparting vibrations to a sonorous body by and in accordance with the resisting record, substantially as described.

2. The method or process of reproducing sounds recorded phonautographically, which consists in copying the phonautographic record in solid resisting material, and then imparting vibrations to a sonorous body by and in accordance with the copy of the orignal record, substantially as described.

3. The method or process of reproducing sounds recorded phonautographically, which consists in copying the phonautographic record in solid resisting material by the process of photo-engraving, and then imparting positive to-and-fro movements to a sonorous body by and in accordance with the copy of the original record, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EMILE BERLINER.

Witnesses:
JULIUS SOLGER,
JACOB G. COHEN.

(No Model.)

# G. H. HERRINGTON.

## METHOD OF RECORDING SPEECH.

No. 392,953. Patented Nov. 13, 1888.

Fig 1.

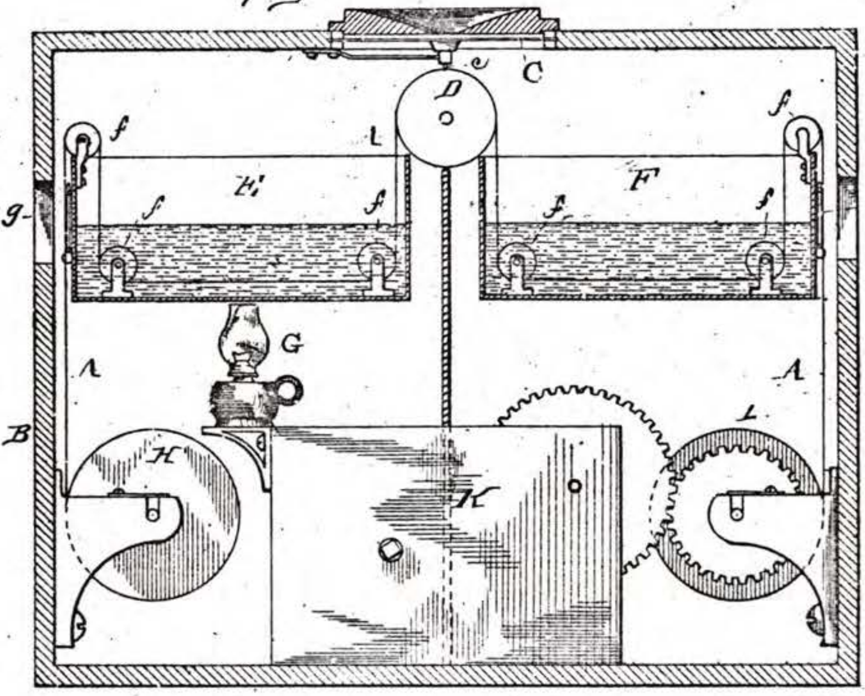
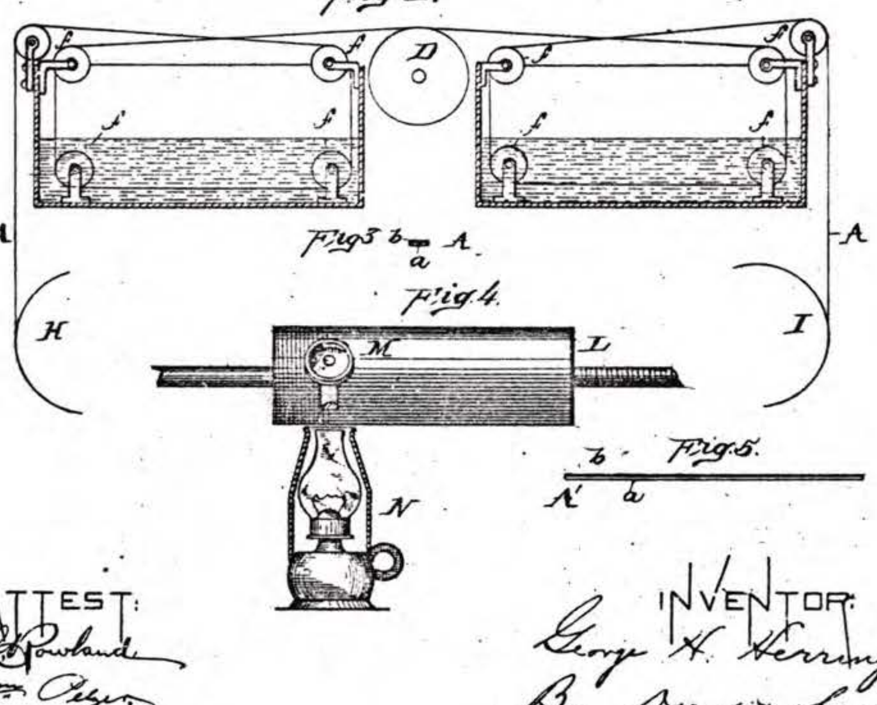


Fig. 2. Fig 3 Fig. 4. Fig. 5.



ATTEST:
E. L. Rowland
Wm. Pelzer

INVENTOR:
George H. Herrington
By Dyer & Seely,
Attys.

# UNITED STATES PATENT OFFICE.

GEORGE H. HERRINGTON, OF NEW YORK, N. Y.

## METHOD OF RECORDING SPEECH.

**SPECIFICATION** forming part of Letters Patent No. 392,953, dated November 13, 1888.

Application filed September 11, 1886. Serial No. 213,278. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE H. HERRINGTON, of New York city, in the county and State of New York, but formerly of Wichita, in the State of Kansas, have invented a certain new and useful Improvement in Phonographs, of which the following is a specification.

Heretofore the great obstacle in the way of the development of the phonograph has been the fact that the mediums used for receiving the indentations or impressions of the diaphragm-needle were necessarily somewhat rigid, in order to preserve the form of such indentations and enable the sound-waves to be reproduced therefrom. This characteristic of the recording medium reduced largely the sensitiveness of the phonograph-diaphragm and made the record incomplete. At the same time the necessity for using a recording medium sufficiently yielding to be to some extent indented by the diaphragm-needle has resulted in the production of records having no degree of permanency and not capable of removal from the machine and transportation to distant points for reproducing the sound-waves when placed upon other machines. It will be seen, then, that a successful recording medium must possess the qualities of minimum softness when passing under the point of the diaphragm-needle in producing the record and of the maximum hardness after the indentations are formed; and it is the object of my invention to produce a method of operation which will accomplish this end.

In carrying my invention into effect I employ as a recording medium to receive the needle-indentations a material capable of being softened or made plastic and of afterward becoming hardened. I cause such surface to receive the indentations while in its softened or plastic condition, and it retains them when it becomes hard again. I prefer to employ a substance such as boiled tar, pitch, resin, asphalt, dental wax, or similar hard substances or compounds, which become plastic when heated and by the employment of heat I soften to the desired degree this surface as it passes under the point of the diaphragm-needle, and then, by cooling, harden the surface to give the record permanency.

The heat affected medium is preferably applied as a coating to a suitable supporting thread, strip, or sheet of metal, fabric, paper, or rubber, and this supporting-body is also preferably flexible, so as to be readily wound upon spools and passed around wheels or drums. The recording-surface may also be covered with an extremely thin metallic foil, or be powdered, to prevent sticking to the needle or to the wheels or rollers while in a plastic condition.

The heat may be applied in any suitable way, and air, water, or steam may be used, the recording medium passing through a heating-chamber, or over or around heating drums or rolls just before reaching the diaphragm-needle. The cooling may be effected by an air or water chamber, or by drums, or by other suitable means.

The phonograph may have a motor to move the recording medium under the point of the diaphragm-needle, and the same machine may, by the removal of the heating and cooling devices, be used to reproduce sound from such a record as has been described.

The same method and essentially the same apparatus can be employed for recording the movements of telephonic or telegraphic apparatus, so as to register messages sent by such instruments, without departing from the spirit of my invention.

In the accompanying drawings, forming a part hereof, Figure 1 is a vertical section of a simple form of apparatus illustrating the invention; Fig. 2, a similar view of some of the principal parts of a modified form of apparatus; Fig. 3, a cross-section of the recording-strip used with the apparatus of Figs. 1 and 2; Fig. 4, a side elevation and partial section illustrating the application of the invention to the ordinary form of phonograph, and Fig. 5 an edge view of a recording-sheet such as would be used with the apparatus of Fig. 4.

The recording-strip A or sheet A′ has a flexible body, *a*, of thin metal, fabric, paper, rubber, or other suitable material, provided with a surface, *b*, of the recording medium—such as boiled tar, pitch, resin, asphalt, hard dental wax, or other similar substance or compound—and this surface may or may not be powdered or covered with extremely thin metallic foil, as before set forth.

In the apparatus shown in Figs. 1 and 2, a suitable box or frame, B, is provided for supporting and inclosing the parts. The ordinary phonograph-diaphragm C is supported in an opening in the top of this box, and beneath the diaphragm is the needle *c*, mounted in the ordinary way. Directly below the needle *c* is the roller D, over which the recording-strip A passes in a suitable guiding-groove, this roller serving to bring the recording-strip into contact with the point of the diaphragm-needle.

Heating and cooling chambers E and F are supported in the box B on opposite sides of the roller D, and are provided with wheels or rollers *f* for guiding and directing the recording-strip. A lamp, G, is shown for heating the chamber E, and the recording-strip passing through it. Thermometers *g* are shown, by which the temperature of the chambers E F can be seen and regulated. Rollers H I carry the recording-strip, and a motor, K, gives the necessary movement to the strip.

In Fig. 2 the wheels or rollers *f* of the heating and cooling chambers are arranged so that in passing around them the recording-surface of the strip will not touch these wheels or rollers.

In Fig. 4 an ordinary phonograph-cylinder, L, is shown, upon which the sheet A′ is placed. The phonograph mouth-piece is shown at M. A lamp, N, is shown for heating the recording-surface of the sheet to a plastic condition as it passes under the diaphragm-needle. The recording-surface is cooled by the air as it passes from the influence of the lamp.

It is evident that the method which constitutes my invention may be employed in many forms of apparatus. The recording medium is made as plastic as possible without injury as it passes under the diaphragm-needle, thus giving the greatest possible freedom of movement to the diaphragm, while the subsequent cooling by the atmosphere or artificially gives the recording medium a permanent hardness. When a message or communication has once been registered on the strip or sheet by a phonograph, telephone, or telegraph-instrument, it can be repeated any number of times, and can be handled without injury to the impressions and sent to any distant point to be repeated without the aid of a skillful operator at that point.

By removing the lamp or other heating medium the same apparatus may be employed to reproduce the sounds by running the strip or sheet under the diaphragm-needle, so that its point will follow the sound-wave impressions or indentations.

It will be understood that I do not limit myself to the use of any particular material or compound as a recording medium, as any material or compound may be employed which, when heated, is sufficiently yielding or plastic to readily receive impressions, and which will set and retain the impressions when cold.

I do not claim herein the apparatus before described for carrying my invention into effect, since I am required by the Commissioner of Patents to embody this in a separate application.

What I claim is—

1. The method of recording sounds or messages for reproduction, consisting in reducing the recording medium to a yielding or plastic condition, passing it through the recording-instrument while in such plastic condition, and then allowing it to harden to set the impressions, substantially as set forth.

2. The method of recording sounds or messages for reproduction, consisting in heating the recording medium to a yielding or plastic condition, passing it through the recording-instrument while in such plastic condition, and then cooling it to set the impressions, substantially as set forth.

This specification signed and witnessed this 10th day of September, 1886.

GEO. H. HERRINGTON.

Witnesses:
Wm. Pelzer,
E. C. Rowland.

(No Model.)

## T. A. EDISON.

### PHONOGRAPH RECORDER.

No. 393,968. Patented Dec. 4, 1888.

Fig. 2

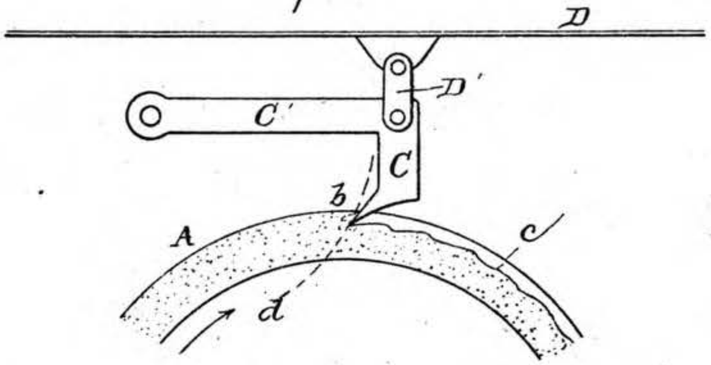


Fig. 1.

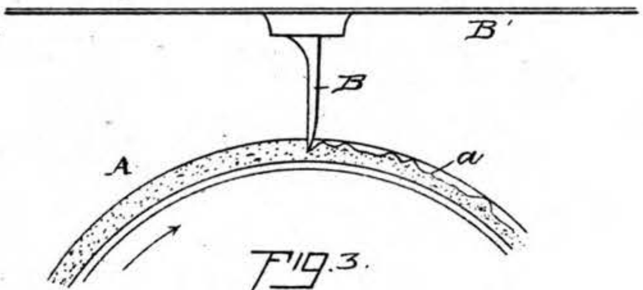


Fig. 3.

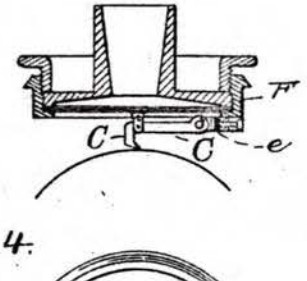
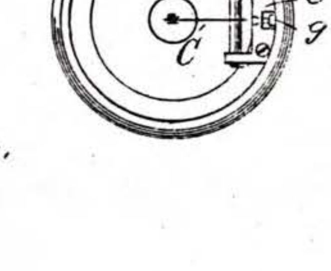


Fig. 4.



WITNESSES:

E. C. Rowland

William Pelzer.

INVENTOR.

Thomas A. Edison

BY

Dyer & Seely

ATTORNEYS.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAPH-RECORDER.

**SPECIFICATION** forming part of Letters Patent No. 393,968, dated December 4, 1888.

Original application filed July 17, 1888, Serial No. 280,209. Divided and this application filed November 5, 1888. Serial No. 290,023. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographs, (Case No. 813,) of which the following is a specification.

In my application filed July 17, 1888, Serial No. 280,209, of which this application is a division, is set forth a method of recording sound-vibrations by cutting the record in the recording-surface as distinguished from impressing such record by a scraping action, and also an apparatus for carrying such invention into effect. In that application the method only is claimed, the Commissioner of Patents having required me to embody the apparatus in a separate application.

For the recording-surface of my phonograph (*i. e.*, the phonogram-blank) I employ a solid material—such as a wax composition or a mixture of metallic soaps capable of being indented by the recording-point. In recording sounds a groove is formed in the material by means of an indenting-point connected with the diaphragm of the recorder, and this groove varies in depth accordingly as the indenting-point is advanced or withdrawn by the vibrations of the diaphragm, thus forming the wave-record from which the sounds are reproduced, as is well understood.

Heretofore the recording-point used has been constructed so that in forming the groove it removed the material by a scraping action. This was due to the fact that the advancing edge of the recording-style used was perpendicular to the recording-surface or receded from the perpendicular, the result being a scraping rather than a true cutting of the material. The scraping action I have found to be productive of false vibrations, which become a part of the record, and which are audible as scratching and other foreign noises when the sounds are reproduced. I have found that this difficulty is overcome by employing a recording-point made as a true cutting-tool with a cutting-edge in advance of the stock of the tool. It might be supposed that a cutting-tool would be unsuitable for the recording-point and that the heel of the tool would strike the bottom of the groove and prevent the formation of a perfect record, or obliterate the record as made by smoothing or pressing out the indentations more or less; but I have found that the movement of the recording-surface is sufficient to keep the heel of the tool clear of the indentations. This adaptability of the cutting-tool form for the recording-point I consider is also due in a measure to the fact that the recording-point in my phonograph is arranged to act more or less obliquely to the recording-surface, so that the recorded waves will begin gradually and end abruptly. This oblique movement may be accomplished in any of the ways described in my application No. 786, (Serial No. 280,204,) in which this particular matter is more fully explained. The recording-point in its forward movement advancing against the movement of the recording-surface, the cutting-tool will clear itself just to the extent that its movement advances from the perpendicular, and thus the speed of the recording-surface will be supplemented in the respect of serving to keep the heel of the tool clear by the oblique movement of the cutting-tool. The waves, being abrupt, need not be as deep, and hence there is less difficulty in clearing the tool.

In my phonograph the cutting-tool recording-point is carried by a lever, which takes the lateral thrust of the tool and relieves the diaphragm of the strain due to that thrust This carrying-lever is also pivoted so as to produce the oblique movement of the recording-point, before referred to. It also is made light, is provided with friction-bearings to overcome the momentum of the diaphragm and attached parts and to take up lost motion, and it is also positively connected with the diaphragm by a pivoted link or other form of connection which will yield in the direction of the length of the lever, so as to prevent the straining of the diaphragm.

While I prefer to employ these several details, yet it is evident that the cutting-tool can be used with phonograph-recorders of various constructions, and hence I do not wish that feature of my invention, except when specially indicated by the claims, to be limited to the details stated. The cutting of the record in the material of the recording-surface instead of scraping it makes a clean smooth record free from imperfections producing scratching or other foreign noises in the reproducer.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, on an exaggerated scale, illustrating the formation of a record by a scraping-style as heretofore. Fig. 2 is a similar view illustrating the use of this invention. Fig. 3 is a vertical section of my phonograph-recorder complete, and Fig. 4 is a bottom view of the recorder.

A is the recording-surface, which may be considered as a wax composition capable of being indented by the recording point or style. It is a given a movement in the direction of the arrows, Figs. 1 and 2.

Heretofore the recording-style B has had its advancing edge perpendicular to the recording-surface or receding from it, as shown in Fig. 1. This produced the record *a* by a scraping action. By my invention the recording-point C, Fig. 2, is a cutting-tool having a cutting-edge, *b*, in advance of the stock of the tool. This produces the record *c* by a true cutting action. The style B is attached directly and only to the diaphragm B′, and hence the wave-record *a* is composed of waves having a symmetrical rise and fall with the deepest part of each wave at its center. The point C is mounted on a pivoted lever, C′, connected with the diaphragm D by a pivoted link, D′ The direction of movement of the cutting-edge of the recording-point C is described by the dotted circle *d;* hence it will be seen that the recording-point C acts obliquely to the recording-surface and produces recorded waves which begin gradually and end abruptly. It will be seen that such is the character of the wave-record *c*. By the movement of the recording-surface and the oblique action of the recording-point the heel of the cutting-tool, forming the recording-point, is kept clear in operation.

From the description that has already been given and an inspection of Figs. 3 and 4 it will be readily understood how my phonograph-recorder is constructed. The lever C′ is carried by a bearing-pin, E, which is pivoted in a yoke, *e*, secured to the annular frame F of the recorder. A spring, *f*, bears against the pin E, and is adjusted in its tension by a screw, *g*. This produces a friction at the bearings of the pin E, which overcomes the momentum of the diaphragm and attached parts by retarding their movement, and also takes up all lost motion at the bearings. The spring-friction produces a non-resilient and constantly-acting retarding device. The pivoted link D′ prevents the diaphragm from being strained by the differences in movement of the diaphragm and the recording-point by reason of the fact that the link, due to its pivots, yields in the direction of the length of the carrier-lever, while it forms a positive connection between the recording-point and the diaphragm.

What I claim is—

1. A phonograph-recorder having for its recording-point a cutting-tool with a cutting-edge in advance of the stock of the tool, substantially as set forth.

2. In a phonograph-recorder, the combination, with the diaphragm, of a cutting-tool recording-point connected with the diaphragm and mounted to move obliquely to the recording-surface, substantially as set forth.

3. In a phonograph-recorder, the combination, with the diaphragm, of a cutting-tool recording-point connected with the diaphragm, and a non-resilient constantly-acting retarding device for retarding the movement of such point in both directions, substantially as set forth.

4. In a phonograph-recorder, the combination, with the diaphragm, of a cutting-tool recording-point connected with the diaphragm, a lever carrying such point, and a positive connection between the point and the diaphragm, which connection is constructed to yield in the direction of the length of the lever, substantially as set forth.

This specification signed and witnessed this 31st day of October, 1888.

THOMAS A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

# G. H. HERRINGTON.

## METHOD OF RECORDING SPEECH.

No. 397,856 Patented Feb. 12, 1889.

Fig 1

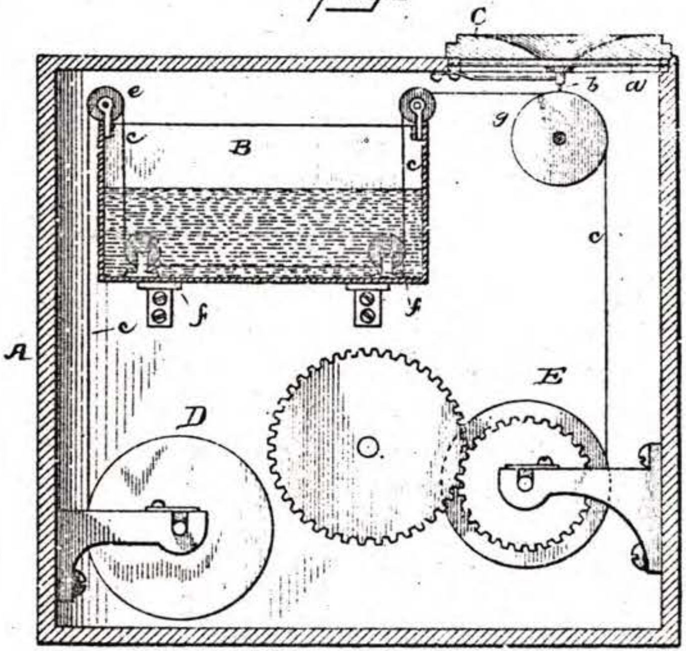


Fig. 2.

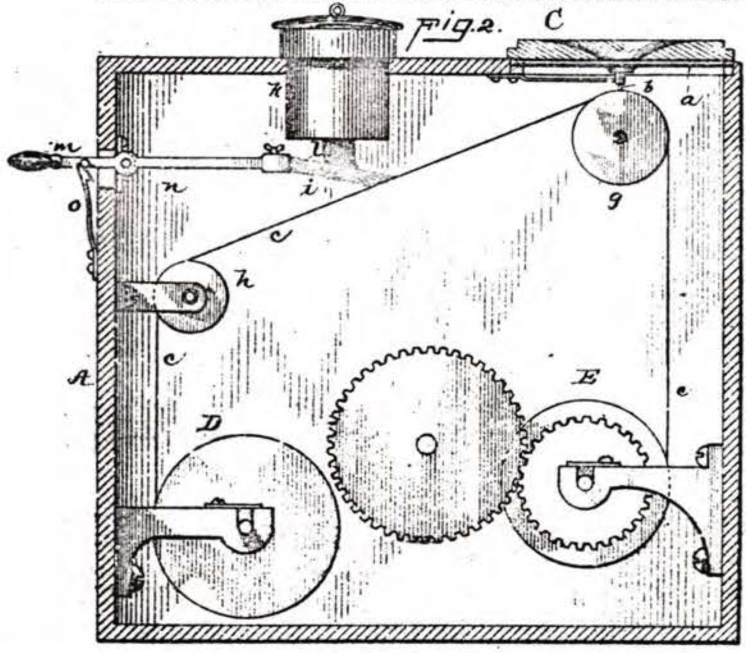
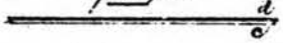


Fig. 3.



ATTEST:

E. C. Rowland.

William Pelzer

INVENTOR:

George H. Herrington

By Dyer & Seely

Attys

, 1889.

# UNITED STATES PATENT OFFICE.

GEORGE H. HERRINGTON, OF WICHITA, KANSAS, ASSIGNOR TO HIMSELF, AND EDWARD H. JOHNSON, OF NEW YORK, N. Y.

## METHOD OF RECORDING SPEECH.

SPECIFICATION forming part of Letters Patent No. 397,856, dated February 12, 1889.

Application filed June 18, 1887. Serial No. 241,795. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE H. HERRINGTON, of Wichita, in the county of Sedgwick and State of Kansas, have invented a certain new and useful Improvement in Phonographs, of which the following is a specification.

In my application filed September 11, 1886, is set forth a process of recording sound-vibrations by softening a material, passing it under the needle of a phonograph, and then allowing it to cool. In the application referred to I described the use as the recording medium of a material capable of being softened by heat and hardening when cooled.

My present invention relates to another specific process to the same end, one of whose advantages is that the appliances required for heating and cooling the material are dispensed with.

My improvement consists, mainly, in the employment as a recording medium of a material which is softened by a chemical solvent before passing under the vibrating needle, and afterward hardens as it dries.

I prefer to place the material upon the surface of a thin flexible strip, which is fed by suitable mechanism from a drum on one side of the apparatus to one on the other side, passing under the vibrating needle, and before reaching such needle coming in contact with the solvent. Suitable materials for the purpose are celluloid, glue, wax, molasses, pitch, asphalt, or various glutinous or resinous substances, or two or more of such substances in combination. A compound which I have found especially advantageous is one of celluloid mixed with a smaller quantity of molasses and beeswax, the celluloid and beeswax being dissolved with ether or other suitable solvents before mixing. This mixture I then spread evenly on a strip of paper or other suitable surface and allow it to dry hard, and then finish it with as smooth a surface as possible. Another combination which I have used to great advantage is one of glue, molasses, and wax, applied in a similar manner to that just described. This forms a particularly smooth and glossy surface, and prevents largely the harsh grating sound, which is an objection when tin-foil is used.

I employ solvents suitable for the particular material used. For instance, with celluloid I may use ether, with glue, and water, which may be heated, or with other materials alcohol, ammonia, or acetic acid, the proper solvent being employed for the material used, as will be readily understood.

Convenient apparatus for carrying my invention into effect is illustrated in the accompanying drawings.

Figure 1 illustrates a form of apparatus in which the strip is passed through a bath of the solvent. Fig. 2 illustrates a form in which the solvent is applied by means of a brush, and Fig. 3 is a view of a portion of the strip.

In Fig. 1, A represents a suitable inclosing box or case. B is a vessel containing the solvent. C is the mouth-piece or ear-piece, *a* the diaphragm, and *b* the vibrating point or needle. D is a spool or drum carrying the strip *c*, on which the sound-vibrations are to be recorded. This is a strip of paper or other suitable flexible material of sufficient strength for the purpose, and is covered with the soluble substance *d*, Fig. 3, such as above described. This strip passes over a roller, *e*, and then over the two rollers *f f* in the vessel B, under the surface of the liquid, then over the roller *g*, which brings it directly under the needle, and, finally, to the receiving drum or spool E, on which it is wound, this drum being revolved by a spring or any suitable motor, as indicated, so as to move the strip when in operation continuously along under the needle. As the strip passes through the solvent its surface is softened by the action thereof, so that it readily receives the impressions of the needle as it vibrates in accordance with sound-vibrations projected against the diaphragm. The drum E is placed at a sufficient distance, so that the surface dries before the strip is wound thereon. The surface of course hardens as it dries, so that the impressions remain permanently thereon.

The drums are preferably removable, so that the drum, with the record upon it, may be removed, and such record may be reproduced by placing the drum in a similar machine, of course with the solvent omitted, and passing it under the needle.

In the form shown in Fig. 2 the strip *c* passes from the spool D to the spool E under

TOR:

the needle, as before. The vessel and the rollers therein are omitted, and the strip passes directly from a roller, *h*, supported on the side of the case to the roller *g* under the diaphragm. Between the rollers *h* and *g* a brush, *i*, rests lightly on the top of the strip. In this case this brush takes the place of the vessel of Fig. 1 as the receptacle for the solvent. A vessel, *k*, is supported by the top of the box, which vessel contains the solvent. From an aperture in the bottom of the vessel a porous body, *l*, which is preferably a mass of fibrous or spongy material—as wicking or sponge—hangs down and rests on the brush *i*, whereby the brush is kept constantly provided with the solvent. The traveling strip is therefore continually moistened with the liquid as it moves and reaches the needle, with its surface in the desired soft and impressible condition. I prefer to provide the brush with a handle, *m*, pivoted at *n* and passing through a slot in the side of the case, whereby when the machine is not in use, or when it is in use for reproducing sound, the strip may be removed from contact with the solvent by pressing down on the projecting handle. A spring-catch, *o*, is preferably provided for holding the brush away from the strip. The drum E is turned by a suitable motor, as before.

I do not claim herein the method of recording sounds by softening the recording medium, passing it through the recording-instrument while in such softened condition, and then allowing it to harden to set the impressions, since this is claimed in my prior application, filed September 11, 1886.

What I claim is—

1. The method herein described of making a permanent record of vibrations, which consists in softening a body of material by a chemical solvent, passing the same through the recording-instrument while it is in a softened condition, and then allowing it to harden.

2. The method of recording phonetic vibrations, which consists in covering a strip of material with a substance capable of being softened by a chemical solvent, subjecting said substance to the action of such solvent, passing it in its softened condition under the vibrating point of a phonograph, and afterward allowing it to harden to fix the phonogram, substantially as set forth.

This specification signed and witnessed this 13th day of June, 1887.

GEORGE H. HERRINGTON.

Witnesses:

RICHARD B. REILAY

F. J. ARNOLD.

(No Model.)

# G. H. HERRINGTON.

## PROCESS OF DUPLICATING PHONOGRAMS.

No. 399,265. Patented Mar. 12, 1889.

*Fig. 1.*

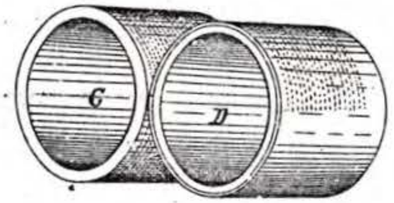


*Fig. 2.*

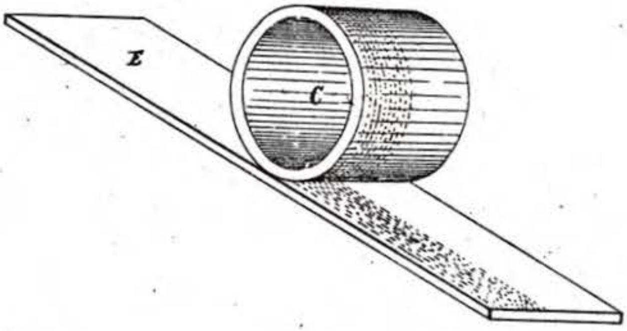
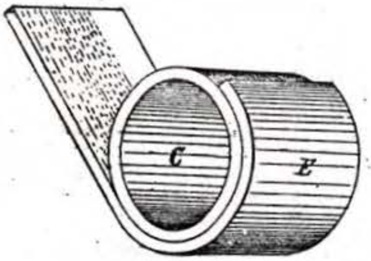


*Fig. 3.*



*Witnesses.*

J. E. A. Smith

J. G. Babb.

*Inventor.*

George H. Herrington.

By Wm J. Hutchins.

Atty.

# UNITED STATES PATENT OFFICE.

GEORGE H. HERRINGTON, OF WICHITA, KANSAS.

## PROCESS OF DUPLICATING PHONOGRAMS.

**SPECIFICATION** forming part of Letters Patent No. 399,265, dated March 12, 1889.

Application filed September 21, 1888. Serial No. 285,978. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE H. HERRINGTON, a citizen of the United States of America, residing at Wichita, in the county of Sedgwick and State of Kansas, have invented certain new and useful Improvements in the Process of Making Duplicate Copies of Phonograms, of which the following is a specification, reference being had therein to the accompanying drawings and the letters and figures of reference thereon, forming a part of this specification.

This invention relates to certain improvements in the process of making duplicate copies of phonograms; and it consists, first, in preparing a phonograph-cylinder with a coating of wax or composition which is adapted to be softened by heat, in registering the sound-waves from a phonograph upon said prepared cylinder while its wax or composition is in a soft state, then in permitting said wax or composition to cool and harden and thus preserve its developed characters; second, in preparing sheets of said wax or composition, in softening said sheets by means of heat, and applying and pressing them about the cylinder having the original phonogram, or rolling said cylinder across said sheet with pressure to impress the phonogram-registrations upon the surface of said sheets, when the sheets are permitted to harden or set, and if about said cylinder removed, and thus said sheets are impressed with a negative duplicate copy of the original phonogram; and, third, in preparing duplicate cylinders with a coating of said wax or composition, and while they are in a soft state from the influence of heat they are either rolled across the sheet having the negative copy or said sheets placed about said cylinders, and in either instance pressure is applied sufficiently to impress a positive duplicate copy in the surface of said duplicate cylinders from the said negative copy. Then each is permitted to set or harden to preserve the duplicates thus obtained.

Figure 1 represents the process of copying the registrations of the sound-vibrations of an original phonogram upon the surface of a cylinder of similar dimensions by means of compression. Fig. 2 represents a similar process of copying said registrations upon a plane surface, and Fig. 3 represents the process of copying said registrations upon a plane sheet of the copying material by means of placing said material about the cylinder having the original record thereon and by holding said material compressed thereabout until the characters are developed.

Referring to the illustrations, *c* represents a phonograph-cylinder having registered thereon the original phonogram.

D represents a cylinder of similar dimensions having a coat or covering of either wax, resin, pitch, celluloid, glue, rubber, or their compound, or some equivalent material adapted to be softened by means of heat or otherwise, so it will receive and retain the impression in reverse duplicate of the record made on the original phonogram by means of rolling the surfaces of the said two cylinders together with sufficient pressure to properly cause the record to be copied. (See Fig. 1.)

E represents a prepared sheet or plane surface of either wax, resin, pitch, celluloid, rubber, or their compound, or some equivalent material, as before stated, which is adapted to be softened by means of heat or otherwise and used in some instances in place of the cylinder D for receiving and retaining in reverse duplicate the record made on the original phonogram by means of rolling the cylinder having the original record over the surface of said sheet or plane with sufficient pressure to properly cause the record to be copied, as in the former manner, (see Fig. 2,) and thus by the process described a fine reverse duplicate or negative of the original phonogram is produced, and when the said copying material upon which the copy is made becomes cool it will set and become firm and retain a rigid copy. In instances where certain kinds of said copying material are used which will form into flexible sheets it is placed about the cylinder having thereon the original phonogram while soft and retained thereon by suitable pressure until the copy has been impressed and the material has become set and the several characters well developed. (See Fig. 3.)

To produce positive duplicates of the original phonogram, duplicate copying cylinders or sheets are prepared in like manner as above described and subjected to the same process and pressure in contact with the cylinder or sheet having the reverse or negative copy of the original phonogram thereon, and when the positive duplicate copies of the original phonogram have set and their registrations have become firm they may be used in reproducing the sound-vibrations in a phonograph.

Any desired number of positive duplicate copies of the original phonogram may be made from the reverse or negative copy thereof in the manner and by the process stated. Duplicate positive copies of the original phonogram may be made from the reverse or negative duplicates thereof on soft wax.

The essential features of my invention consist in using one or more of the materials as follows: wax, resin, pitch, celluloid, glue, rubber, or their compound or equivalent, applied to a cylinder or roll or formed in plane sheet or strips, wherein they are adapted to be softened by means of heat or otherwise, so as to receive and retain, first, the reverse duplicate copy of the original phonogram, and, second, by using the said reverse duplicate copy for producing positive duplicate copies of the original phonogram.

The use to which this process of duplicating the registrations of the sound waves or vibrations is applied is in phonographs or any machine calculated to register sound waves or vibrations, as in telegraphic, electric, and other minute operations of similar character.

I am aware of the use of plastic material and materials adapted to be softened in various ways and impressed with characters and permitted to set or harden while in contact with the object of which the impression is taken; but I am not aware that the herein-described process has heretofore been used, wherein a phonograph-cylinder is first covered with a coating of wax or composition which is adapted to be softened by heat and the phonogram-record made thereon while said coating is softened from the influence of heat, then permitted to harden, then in preparing sheets or strips of said wax or composition material and applying said sheets in contact with the original recorded cylinder when in a soft state from the influence of heat, thus impressing said sheet with a negative copy of the original record, then permitting said sheet to set to preserve the form of its copy, and removing it apart from the original record and applying duplicate cylinders, which are prepared with a coating of said wax or composition, in contact with said negative copy of said sheet while said duplicate cylinders are softened from the influence of heat, so they will receive in their surface an impressed positive duplicate copy of the original phonogram, and then permitted to harden to preserve such copy, thus producing any number of positive duplicate copies of the original phonogram-record in such form as that it may be used in reproducing the sound-vibrations in a phonograph.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows, to wit.

1. The herein-described process of making duplicate copies of original phonograms, consisting in preparing a phonograph-cylinder with a coating of wax or composition which will soften under the influence of heat, thus forming a surface upon which to register the phonogram when said surface is in a soft state, then permitting said recorded surface to harden, in applying a sheet or strip prepared from said wax or composition, while in a soft state from the influence of heat, in contact with said hardened recorded surface of the original phonogram, impressing said sheet or strip with said record, and while in such contact permitting the wax or composition to set, in removing said impressed sheet or strip from contact with the record, thus producing a negative duplicate copy, and in applying duplicate cylinders having a coating of said wax or composition in contact with said negative copy while the coatings of said cylinders are softened from the influence of heat, impressing in their surface a positive duplicate copy of the original phonogram from said negative, substantially as and for the purpose specified.

2. The herein-described process of making duplicate copies of original phonograms, consisting in pressing sheets of wax or composition which is adapted to soften from the influence of heat in contact with the original phonogram while in a soft state, then permitting it to set, thus impressing said sheet with the original record, in removing said sheet or strip from contact with the original record, thus forming a negative duplicate copy, and in applying duplicate cylinders having a coating of said wax or composition in contact with said negative copy while the coatings of said cylinders are softened from the influence of heat, thus impressing in their surface a positive duplicate copy of the original phonogram from the negative record, substantially as and for the purpose specified.

GEORGE H. HERRINGTON.

Witnesses:
F. E. A. SMITH,
J. G. BABB.

# UNITED STATES PATENT OFFICE.

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THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION** forming part of Letters Patent No. 400,648, dated April 2, 1889.

Application filed July 30, 1888. Serial No. 281,457. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 796,) of which the following is a specification.

The object of my invention is to produce phonogram blanks or bodies on which are to be produced a record of sound-vibrations, and which are to reproduce the same by the aid of the phonograph, which phonogram-blanks shall be composed of a material having superior qualities for receiving such record and reproducing sound therefrom.

I have found that the various waxes are very desirable to use in the composition of such phonogram-blanks, but that most waxes if used by themselves are too soft to be used for this purpose. I therefore mix with the wax a harder material, which will produce a harder compound.

I have found that stearic acid is an exceedingly desirable hardening material for this purpose. I may mix this material with any suitable wax—such as ceresin, beeswax, or paraffine—but of these materials I prefer to use ceresin either alone or mixed with a small percentage of beeswax. I prefer the yellow ceresin, because it is cheaper than white ceresin.

I have found the best mixture to be as follows: About one hundred parts, by weight, of ceresin, about twenty-five parts of beeswax, and about twenty-five parts of stearic acid. The materials are simply melted together by heat and the melted compound is molded in suitable molds into the shape required for the phonogram-blanks, preferably into the form of hollow cylinders.

What I claim is—

1. Phonogram-blanks made of a mixture of a wax with stearic acid, substantially as set forth.

2. Phonogram-blanks made of a mixture of ceresin and stearic acid, substantially as set forth.

3. Phonogram-blanks made of a mixture of ceresin, beeswax, and stearic acid, substantially as set forth.

4. Phonogram-blanks made of a mixture of ceresin, beeswax, and stearic acid, in about the proportion, by weight, of one hundred parts of ceresin, twenty-five parts of beeswax, and twenty-five parts of stearic acid, substantially as set forth.

This specification signed and witnessed this 27th day of July, 1888.

THOS. A. EDISON.

Witnesses:
RICHD. N. DYER,
WILLIAM PELZER.

(No Model.)

# T. A. EDISON.

## METHOD OF MAKING PHONOGRAM BLANKS.

**No. 400,649.** **Patented Apr. 2, 1889.**

FIG. 1.

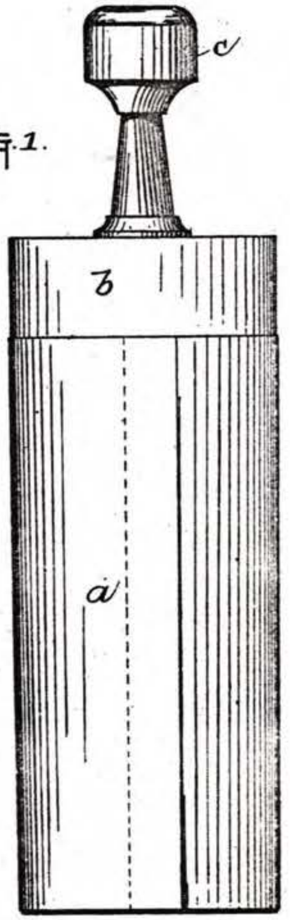


FIG. 2.

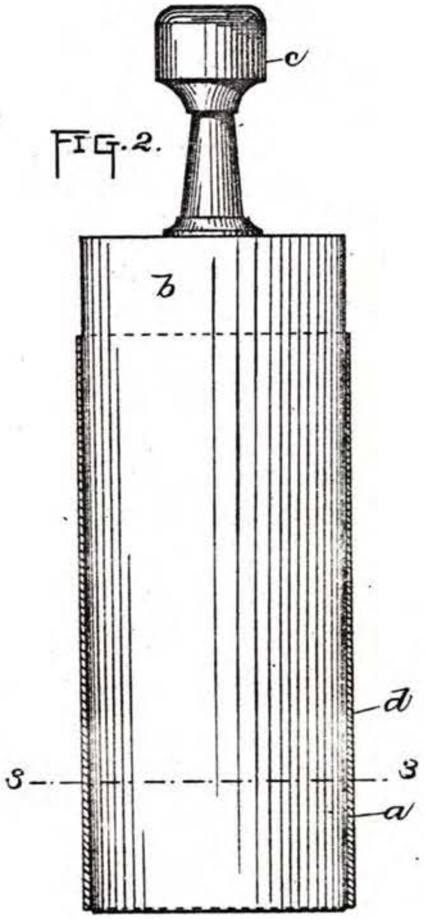
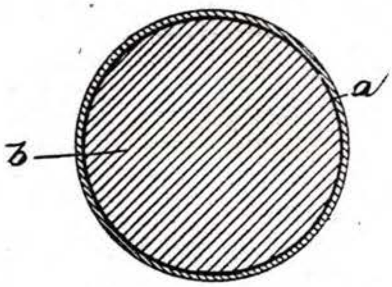


FIG. 3.



WITNESSES:
E. C. Rowland.
William Pelzer

INVENTOR
Thomas A. Edison
BY
ATTORNEYS.

1889.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## METHOD OF MAKING PHONOGRAM-BLANKS.

**SPECIFICATION** forming part of Letters Patent No. 400,649, dated April 2, 1889.

Application filed October 11, 1888. Serial No. 287,843. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Methods of Making Phonogram-Blanks, (Case No. 807,) of which the following is a specification.

The object of my invention is to produce, in a simple and expeditious manner, cylindrical phonogram-blanks made of paper or other flexible material covered with a material which can be indented by the recording-point of the phonograph.

In carrying my invention into effect, I first take a sheet of paper or other flexible material of the proper size, and I wrap this upon a tapering core which is provided with a handle. I secure the paper together at its edges, and I then, holding the core by the handle, dip it into a bath of the material to be applied to it while such material is in a softened condition. This material is preferably a wax or a composition of waxes or a suitable metallic soap. After the paper is dipped and becomes coated to a sufficient thickness with the indenting material, it is placed in a lathe, and its surface is turned off into a true cylindrical form, it being at first in the tapering form of the dipping-core. The phonogram-blank being then removed from the core is ready for use.

My invention is illustrated in the accompanying drawings.

Figure 1 is an elevation of the paper wrapped on the dipping-core; Fig. 2, a section of the same after dipping and turning, the core being in elevation; and Fig. 3, a cross-section on the line 3 3 of Fig. 2.

The sheet of paper *a* is wrapped upon the tapering cylindrical core *b*, which has a handle, *c*, and its overlapping edges are gummed or otherwise secured together. The paper thus assumes a form like that of the core. The core is then held by the handle and the paper dipped into the material, as above described, and this material *d* adheres to the surface of the paper, whereby a hollow cylinder tapering both inside and outside is produced. This is then turned off in a lathe into the shape shown in Fig. 2—that is, so that it has a cylindrical outer surface and a tapering bore, whereby on being removed from the forming-core it can readily be placed upon the cylinder of the phonograph and recorded upon.

In placing the cylinder in the lathe, I prefer to leave it on the forming-core, this being provided with depressions at its ends (shown in dotted lines) for holding it in the lathe.

What I claim is—

The method of making a phonogram-blank, which consists in wrapping a sheet of flexible material upon a tapering cylindrical core, dipping the same into the sound-recording material, which is caused to adhere to its surface, and then turning off the surface of such material into a true cylindrical form, substantially as set forth.

This specification signed and witnessed this 29th day of September, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

# T. A. EDISON.

## METHOD OF MAKING PHONOGRAM BLANKS.

No. 400,650. Patented Apr. 2, 1889.

FIG. 1

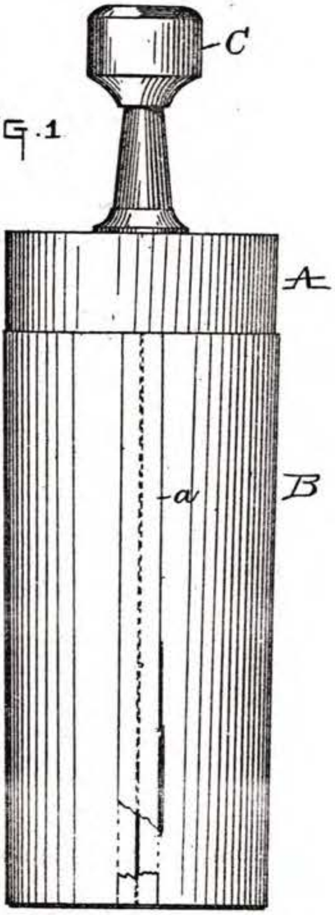


FIG. 2

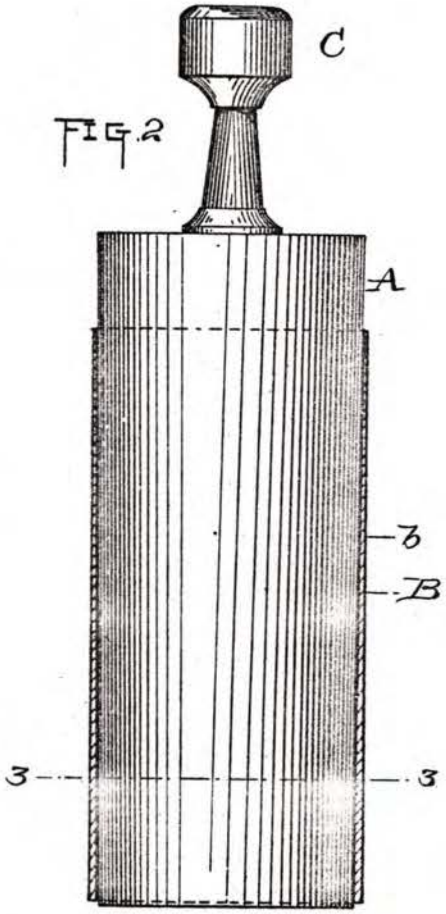


FIG. 3.

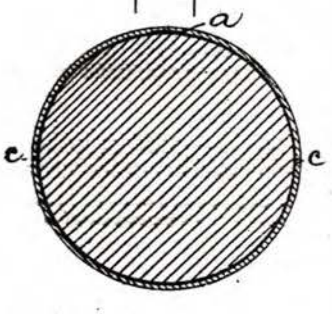
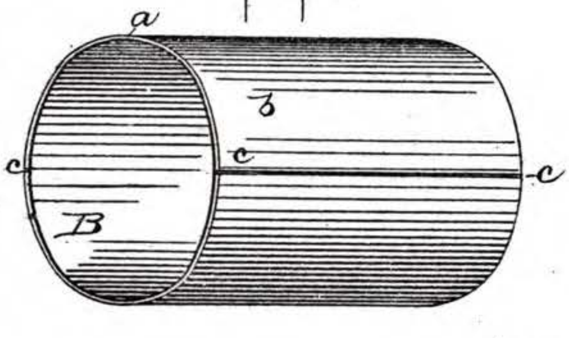


FIG. 4.



WITNESSES:

E. C. Rowland

William Pelzer

INVENTOR,

Thomas A. Edison

BY

ATTORNEYS.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## METHOD OF MAKING PHONOGRAM-BLANKS.

**SPECIFICATION** forming part of Letters Patent No. 400,650, dated April 2, 1889.

Application filed October 17, 1888. Serial No. 288,361. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex, in the State of New Jersey, have invented a certain new and useful Improvement in Methods of Making Phonogram-Blanks, (Case No. 809,) of which the following is a specification.

In my application filed September 19, 1888, Serial No. 285,794, is shown and described a collapsible phonogram-cylinder—that is, one which can be folded into a flat shape for transmittal by mail or otherwise.

My present invention relates to the method of making such collapsible phonogram-blanks.

In carrying my invention into effect I wrap a sheet of paper or other suitable flexible material upon a tapering cylindrical form or core, so that the edges of the paper meet, and I secure the said edges together by pasting a thin strip of tissue-paper upon the outside. I then dip the paper on the core into melted material, such as a wax, or a mixture of salts of fatty acids, such as oleate of lead and palmitate of magnesium. This material adheres to the surface of the paper and forms a coating which can be indented by the recording-point of the phonograph. This coating is turned off in a lathe, so that it has a true cylindrical surface, it being, after dipping, of a tapering shape corresponding to that of the core on which the paper is wrapped.

By means of a suitable tool or machine I then scrape the indenting material off the surface of the paper on two narrow lines directly opposite each other and extending the whole length of the cylinder. This forms points on which the cylinder can be collapsed or folded into a flat form, the paper forming an edge for folding. The use of the strip of tissue-paper for joining the edges, in place of overlapping the edges and securing them together, prevents any irregularity of the inner surface of the cylinder, and as the strip of tissue-paper is covered with the sound-recording material it does not affect the external surface of the phonogram-blank.

The above-described process is illustrated in the accompanying drawings.

Figure 1 shows the paper wrapped and secured upon the core, the view being in elevation. Fig. 2 shows the same after dipping in section. Fig. 3 is a cross-section of the core on the line 3 3 of Fig. 2, with the paper on it, after scraping off the material on two lines; and Fig. 4 is a perspective view of the complete phonogram-blank.

A is the tapering cylindrical core made of suitable metal, and B is the sheet of paper or other flexible material wrapped thereon and secured at its meeting edges by the thin strip of tissue-paper *a*, a portion of which is broken away in the drawings to show the edges of the paper.

In dipping the cylinder into the melted sound-recording material it is held by its handle C. After dipping and turning off the cylinder is as illustrated in Fig. 2—a paper having a coating, *b*, of the material, which receives the record, and having a tapering bore and a true cylindrical outer surface. Before or after removing the phonogram-blank from the core the material is scraped from the surface of the paper on two lines, *c c*, exactly opposite each other and extending the whole length of the cylinder. It will be seen that the cylinder can be folded together on these lines, and then forms a flat body suitable for inclosing in an ordinary envelope, and such body may readily be drawn out again into cylindrical shape and placed upon the cylinder of the phonograph, or upon a false shell placed on said cylinder.

What I claim is—

1. The method of making a collapsible phonogram-blank, which consists in folding flexible material into cylindrical form, covering the same with sound-recording material, and removing such material on two opposite lines, substantially as set forth.

2. The method of making a phonogram-blank, which consists in folding flexible material into cylindrical shape, with its edges meeting, securing such edges by a thin strip pasted on the outside of the cylinder, and covering said cylinder with sound-recording material, substantially as set forth.

3. The method of making a collapsible phonogram-blank, which consists in wrapping flexible material upon a core, securing it together at its edges, dipping it in sound-recording material, so that the same adheres to

its surface, and removing such material on two lines opposite each other, substantially as set forth.

4. The method of making a collapsible phonogram-blank, which consists in wrapping flexible material upon a tapering core, securing it together at its edges, dipping it into sound-recording material which adheres to its surface, turning off such material into cylindrical form, and removing such material on two lines opposite each other, substantially as set forth.

This specification signed and witnessed this 15th day of October, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
A. W. KIDDLE.

(No Model.)

# T. A. EDISON.

## PHONOGRAPH.

No. 406,570. Patented July 9, 1889.

FIG. 1

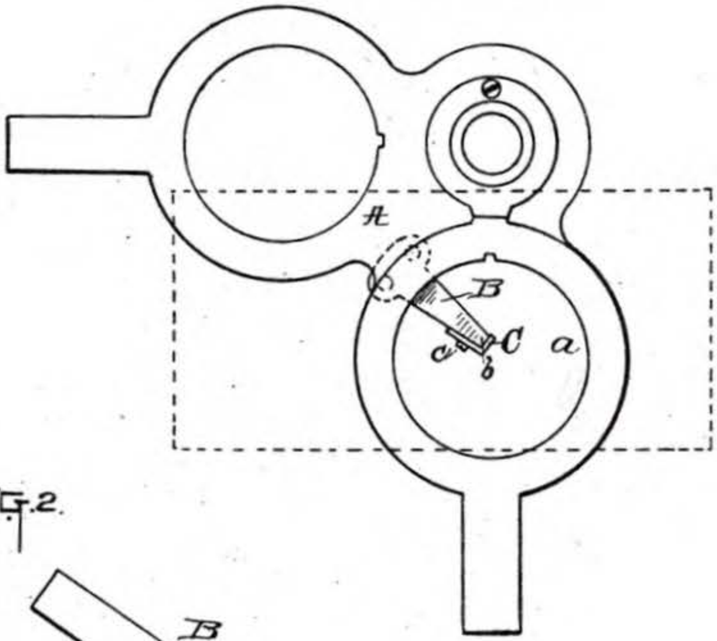


FIG. 2.

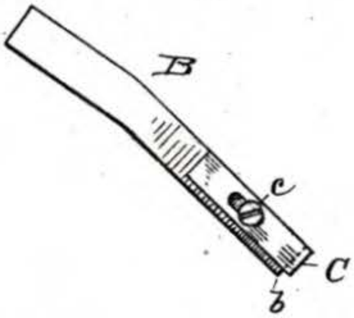
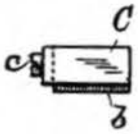


FIG. 3



WITNESSES:

E. Rowland

INVENTOR

Thomas A. Edison

BY

ATTORNEYS

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAPH.

SPECIFICATION forming part of Letters Patent No. 406,570, dated July 9, 1889.

Application filed February 11, 1889. Serial No. 299,452. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographs, (Case No. 820,) of which the following is a specification.

The object I have in view is to prevent wholly or in a measure the effect of the electrification of the chips which are produced by turning off the surface of the phonogram-blanks. I use for my blanks a hard composition—such as a hard metallic soap—and this composition, as well as all hard wax compositions, produces in turning chips which have a high degree of electrification, and which adhere to the cylinder and to the cutting-knife, as well as to the point of the recorder, and injure the surface of the record produced by the recorder, the recording being performed at the same time that the surface is turned off, as has been made clear by applications for patent already filed by me. I have found that the evil effects of the electrification of the chips will be done away with in a measure by breaking up or powdering the chips as they are produced, and this I accomplish by providing the turning-off knife with a shoe, which breaks or powders the chips into small pieces as they rise from the cutting-edge of the knife.

In the accompanying drawings, forming a part hereof, Figure 1 is a top view of the spectacle-frame of my phonograph, showing the cutting-knife with breaking-shoe in position for operation. Fig. 2 is a side view of the knife, and Fig. 3 is an end view of the knife.

A is the spectacle-frame, in the eye *a* of which is placed the recorder. The turning-off tool B is secured rigidly to the spectacle-frame and projects toward the center of the eye *a* and downwardly toward the surface of the phonogram-blank. The edge *b* of the knife bears obliquely upon the surface of the blank and acts as a turning-tool for turning off the surface of the blank, producing a chip of the material of the phonogram-blank, as will be well understood. The breaking-shoe C is a plate which crosses the end of the knife above the cutting-edge *b*, and is bent at right angles, extending along one side of the knife, to which it is secured by means of a slot and a set-screw *c*, which permit proper adjustment of the breaking-shoe with relation to the cutting-edge *b*. The shoe C, being directly above the cutting-edge and projecting beyond it, forms a shoulder, against which the chips strike as they rise from the cutting-edge, and, the material being brittle, the effect is to powder or break the chips into small particles, which will drop off of the surface into the receptacle provided for the turnings.

What I claim as my invention is—

1. In a phonograph, the turning-off tool provided with a breaking shoe or shoulder for powdering or breaking the chips, substantially as set forth.

2. In a phonograph, the combination, with the turning-off tool, of a breaking-shoe adjustably secured thereto and acting to powder or break the chips, substantially as set forth.

This specification signed and witnessed this 1st day of February, 1889.

THOMAS A. EDISON.

Witnesses:
W. PELZER,
D. H. DRISCOLL.

(No Model.)

# T. A. EDISON.

## PROCESS OF TREATING PHONOGRAM BLANKS.

No. 406,571. Patented July 9, 1889.

FIG. 1.

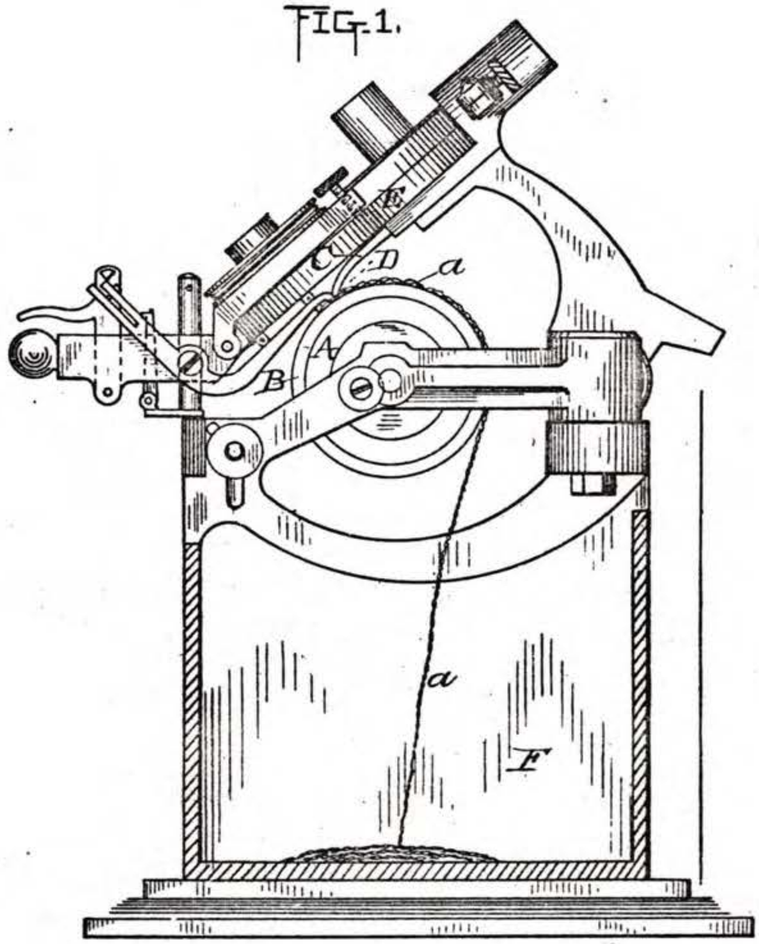
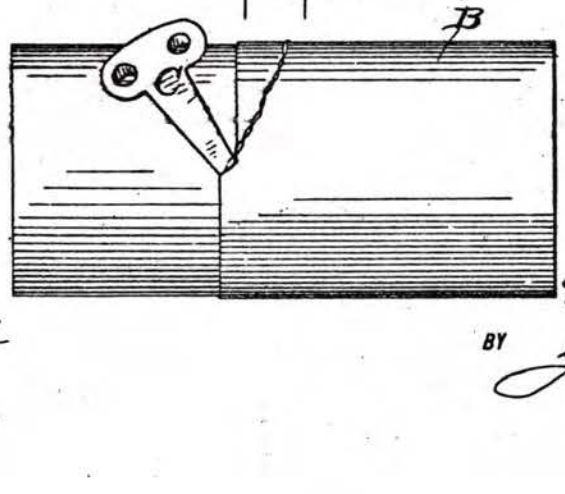


FIG. 2.



WITNESSES:

E. Rowland

W. Pelzer

INVENTOR

Thomas A. Edison

BY

ATTORNEYS

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PROCESS OF TREATING PHONOGRAM-BLANKS.

**SPECIFICATION** forming part of Letters Patent No. 406,571, dated July 9, 1889.

Application filed February 11, 1889. Serial No. 299,454. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Process of Treating Phonogram-Blanks, (Case No. 822,) of which the following is a specification.

My improved phonograph, as is well known, is provided with a turning-off tool for turning off the surface of the phonogram-blank. This is mounted, preferably, to operate with the recorder, so that the old record will be turned off at the same time that a new record is made.

For my phonogram-blank I employ a hard brittle material, such as a hard metallic soap or a mixture of wax with some hardening material. The chips which are produced in turning off such a blank have a high degree of electrification, which, I consider, is due to the rending of the material. They adhere to the surface of the blank and interfere seriously with the action of the recorder. They also adhere to the adjoining parts of the machine, and when it is attempted to brush or blow them off of the blank they fly in all directions and cover surrounding objects. The harder the material of the phonogram-blanks the greater seems to be the electrification of the chips, and since such hard materials produce the most perfect records it will be seen that the difficulty is one of importance. How to overcome this obstacle has proved one of the most difficult problems to solve which I have met with in my work upon the phonograph. I have found that by applying to the surface of the blank just before turning it off a solution which will slightly dissolve the material of the blank, or which will produce a chemical reaction upon such surface, so as to soften and toughen the surface, a continuous chip will be produced by the turning-off tool, which has little or no electrification, or the electrification of which is less powerful than the weight of the chip, so that the chip falls into the receptacle beneath the blank and leaves the surface of the blank perfectly clean for the recording-point, the dust produced by which can be readily blown or brushed off of the surface. The action of the solution does not penetrate to as great a depth as the turning-off tool, since the surface upon which the recorder acts must be of the hard material. My turning-off tool takes a chip about seven one-thousandths of an inch thick. The penetration of the solution to the depth of five one-thousandths of an inch, or even less, will be sufficient to accomplish the purpose. The chip is made continuous. It is wet, and hence not electrical. The surface upon which it falls as it leaves the point of the turning-off tool is the wet uncut and unelectrified surface, and the chip is made heavier by the absorption of the solution. All or part of these conditions may be instrumental in producing the result.

Instead of using a solution which attacks the surface of the blank and produces a tough film of the material of the surface itself, a coating may be applied which adheres to the surface and on drying produces a tough film which forms a part of the chip and serves to hold it together as a continuous strip, so that the weight of the chip will be greater than the electrification of its under surface.

The material employed to soften and toughen the surface of the blank will depend, of course, upon the composition of the blank itself. For blanks made from hard metallic soaps, which I prefer, I may employ a weak alkaline solution, such as a one-per-cent. solution of caustic soda. The strength of the solution will vary upon the depth of the chip and the nature of the substance acted upon. With blanks of the hard metallic soaps I have found that water may be employed, since such soaps seem to be slightly soluble. The weak alkaline solution or the water is applied with a sponge after the blank is placed upon the machine, the surface being completely wet with the solution and any surplus being removed, if necessary, by a dry sponge or piece of chamois-skin. When the surface is dry, the spectacle-frame carrying the turning-off tool and the recorder is lowered into position, when a record is made and the surface turned off simultaneously.

With phonogram-blanks of other substances or compositions solvents or softeners of the particular substances of the blanks will be employed.

To produce tough films upon the surface of the blanks many substances may be applied to the blanks, such as gum-balata dissolved in bisulphide of carbon, or gun-cotton dissolved in acetate of amyle, or glue and water.

In the accompanying drawings, forming a part hereof, Figure 1 is a sectional view of the phonograph, showing the turning-off tool and recorder in position for operation; and Fig. 2 is a top view of the phonogram-blank and turning-off tool.

A is the phonogram-cylinder, upon which is the removable phonogram-blank B, made with a considerable body of the recording material, so that a number of records can be made upon it by turning off old records.

C is the turning-off tool, and D is the point of the recorder. The recorder and turning-off tool are mounted upon the spectacle-frame E and are brought into operation at the same time.

The surface of the phonogram-blank is treated as has been explained. The chip *a* produced by the turning-off tool falls into the receptacle F.

What I claim as my invention is—

1. The process of treating phonogram-blanks having hard brittle surfaces, consisting in producing a tough film upon the surfaces of such blanks preparatory to turning them off, substantially as and for the purpose set forth.

2. The process of treating phonogram-blanks having hard brittle surfaces, consisting in applying to such blanks preparatory to turning them off a solution which attacks the substance of the blanks and softens and toughens the surface, substantially as and for the purpose set forth.

This specification signed and witnessed this 1st day of February, 1889.

THOMAS A. EDISON.

Witnesses:
W. PELZER,
D. H. DRISCOLL.

(No Model.)

# T. A. EDISON.

## PHONOGRAM BLANK.

No. 406,576. Patented July 9, 1889.

Fig. 1.

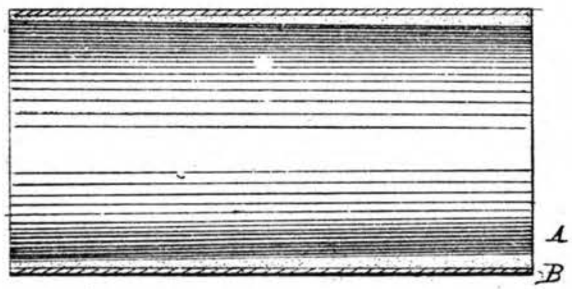
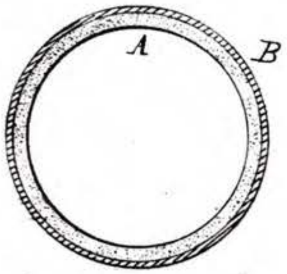


Fig. 2.



Witnesses
E. C. Rowland
William Pelzer

Inventor
Thomas A. Edison

By his Attorneys
Dyer & Seely

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

SPECIFICATION forming part of Letters Patent No. 406,576, dated July 9, 1889.

Application filed February 16, 1889. Serial No. 300,514. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 829,) of which the following is a specification.

My invention relates to that character of phonogram-blanks which consist of a base or backing of one material, usually a molded material, and an outer surface or covering of another material, which receives the sound-record. Such outer recording material has usually heretofore been a material which is more or less soft and pliable at ordinary temperatures; but I have found it better for the purpose of recording and reproducing sounds to employ a material which is hard and brittle at such temperatures. When such a material is employed, difficulty may arise in cases where the phonogram-blanks are exposed to extreme changes of temperature, because the non-pliability of the sound-recording material does not permit it to accommodate itself to the expansions and contractions of the body of the blank, and so the outer material may become cracked. When the outer material is soft and pliable at ordinary temperatures, this difficulty does not usually occur, although it may arise when an extremely low temperature is encountered.

The main object of my invention is to avoid this difficulty; but a further object is to produce a phonogram-blank which can be cheaply and readily produced, and which will be effective in every way for the purpose of recording and reproducing sounds.

My invention consists, mainly, in constructing the two parts of the phonogram-blank—that is to say, the core or backing and the outer covering of sound-recording material—of substances which have the same or practically the same coefficient of expansion under changes of temperature, whereby both parts of the phonogram-blank are made to expand and contract equally, and the cracking of the outer-surface material does not occur.

I prefer to employ for the outer sound-recording surface a thin coating of a metallic soap—such as stearate of soda—and for the core or main portion of the blank I prefer to use asphalts or bitumens. Under these terms I refer not only to the natural asphalts—such as Trinidad, Cuban, Mexican, and Syrian asphalts—but also to the asphaltic residues which are produced artificially in various commercial operations, such as asphalt pitch and hard coal-tar pitch. I find that the best results are produced by the use of Syrian asphalts; but this is more expensive than some of the others, and I therefore prefer to use asphalt pitch, which is ordinary Trinidad asphalt from which the more volatile elements have been distilled. This substance is very cheap, and is found to be very effective for the purpose. In making the phonogram-blank I prefer to mix with the asphalt or bitumen a small percentage of a material which in solidifying shrinks or contracts greatly, such as certain waxes, and preferably carnauba-wax. The reason for this is, that when asphalt is melted and poured into molds it does not contract in hardening, and it is therefore difficult to get it out of the mold again. By mixing from five to seven per cent. of carnauba-wax with the asphalt a compound is formed which shrinks slightly in hardening, and can therefore be readily removed from the mold.

Asphalts as found on the market vary in the degree of heat required to melt them, and also in the degree of liquidity or mobility of the liquid which is formed by melting them. Some asphalts, even at very high temperatures, form a thick semi-liquid which is difficult to pour. This difficulty may be corrected by adding to the asphalt before melting a small quantity of a wax which has a low melting-point—such as Japan wax or ozocerite; or instead of this a liquid—such as crude petroleum, turpentine, or melted rosin or tar—may be used.

In forming the phonogram-blanks, which I prefer to make in the shape of hollow cylinders having a tapering bore and a true cylindrical outer surface, I pour the melted mixture of asphalt, carnauba-wax, and softening material into a suitable mold, such mold having a cylindrical outer inclosure and a tapering inner core, such inner core being preferably first coated with paper, which will adhere to the asphalt cylinder and allow it to be easily removed. I prefer to use a split mold, so that the cylinder can be readily removed from the mold. The outer coating, which, as stated, is preferably a metallic soap having the same coefficient of expansion as the asphalt compound employed, is preferably applied by dipping the asphalt cylinder after it has cooled into a bath of the melted material. When it is applied in this way, the surface may be afterward made true by turning it off in a suitable lathe after it has become cooled again. Instead of this, however, the external material may be also applied by molding, the asphalt cylinder being placed in a mold which is slightly larger than that first used and the covering material poured into such mold round the cylinder, so that it will adhere thereto and will form a smooth and true surface without the necessity of turning it off. My experience has been, however, that the first-mentioned method is the less expensive. There are other ways of forming the asphalt body than by melting and molding. The material may be powdered and subjected to heavy pressure in a suitable mold, so as to form it into the required shape, or it may be formed in a squirting-press—such as is used to make lead pipe—the melting material being forced through the opening in the press in a continuous tube and afterward cut into the desired lengths and then covered with the sound-recording material.

I find that the proportions of asphalt, carnauba-wax, and liquefying material necessary to produce a compound having the proper grade of expansion for the outer covering depends on the character and quality of the material and must be separately determined by experiment for each material used. In order to determine it, the three materials may be mixed in different proportions, the cylinders molded and dipped into the melted covering material, and when several cylinders of different proportions are produced in this way they may be placed in a chamber in which they are subjected to very low temperature. If the coefficient of expansion is not clearly the same, cracks will appear in the outer coatings, which will be more or less according to the proportions of material. This will show how closely the right proportions have been reached in each case, and in the second experiment it will be easy to proportion the ingredients so as to prevent cracking altogether with the particular materials used; but of course if other materials are used it will be necessary to repeat the experiment.

It will be seen that I am thus enabled to use as the sound-recording material a hard and brittle substance, and thus to make phonogram-blanks which are most effective for the recording and reproduction of sound, and at the same time the main portion of the blank is composed of a cheap and easily-worked material, and the blanks can therefore be cheaply and readily produced.

The accompanying drawings illustrate a cylindrical phonogram-blank embodying my invention.

Figure 1 is a longitudinal section of the cylinder, and Fig. 2 an end view thereof.

A is the inner body or core, and B the outer surface of sound-recording material.

What I claim is—

1. A phonogram-blank composed of a base and an outer recording-surface of different materials having the same or substantially the same coefficient of expansion, substantially as set forth.

2. A phonogram-blank composed of a base of one material and a sound-recording surface of a different material, which is of a hard and brittle nature at ordinary temperatures, the two materials having the same or substantially the same coefficient of expansion, substantially as set forth.

3. A phonogram-blank having, in combination, a base of asphaltic material and an outer covering of sound-recording material, substantially as set forth.

4. A phonogram-blank having, in combination, a base of molded material and an outer covering of material having the same or substantially the same coefficient of expansion, substantially as set forth.

5. A phonogram-blank having, in combination, a base of molded material and an outer covering of another molded material, the two materials having the same or substantially the same coefficient of expansion, substantially as set forth.

6. A phonogram-blank having, in combination, a base of asphalt mixed with a material which contracts greatly in solidifying, such as carnauba-wax, and an outer covering of sound-recording material, substantially as set forth.

7. A phonogram-blank having, in combination, a base of asphalt mixed with a liquefying material, and an outer covering of sound-recording material, substantially as set forth.

8. A phonogram-blank having, in combination, a base of asphalt mixed with a material which contracts greatly in solidifying, such as carnauba-wax, and also with a liquefying material, and an outer covering of sound-recording material, substantially as set forth.

9. A phonogram-blank having an outer surface of metallic soap and a base of another material having the same or substantially the same coefficient of expansion, substantially as set forth.

10. A phonogram-blank having a base of asphaltic material and an outer surface of metallic soap, substantially as set forth.

This specification signed and witnessed this 1st day of February, 1889.

THOMAS A. EDISON.

Witnesses:
W. PELZER,
D. H. DRISCOLL.

(No Model.)

# T. A. EDISON.

## PHONOGRAM BLANK.

**No. 414,759.** **Patented Nov. 12, 1889.**

FIG. 1.

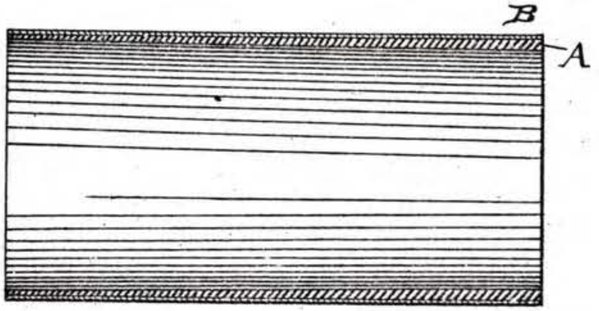
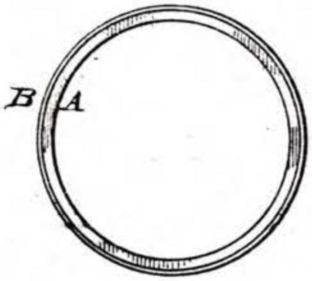


FIG. 2.



WITNESSES:
E. C. Rowland.
W. Pelzer

INVENTOR
Thomas A. Edison
BY
ATTORNEYS

1889.

# UNITED STATES PATENT OFFICE.

THOMAS ALVA EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION** forming part of Letters Patent No. 414,759, dated November 12, 1889.

Application filed March 25, 1889. Serial No. 304,716. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS ALVA EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 830,) of which the following is a specification.

My invention relates to that character of phonogram-blanks which consist of a base or backing of one material, usually a molded material, and an outer surface or covering of another material, which receives the sound-record.

In my application, Serial No. 300,514, filed February 16, 1889, I have described a phonogram-blank of the character just referred to, which is designed to obviate some of the defects existing in other phonogram-blanks. In said application this is accomplished by combining with the core or backing of the blank a recording-surface having the same or practically the same coefficient of expansion as the core or backing. Asphalts or bitumens for the core or backing and a coating of metallic soap for the recording-surface are described as the preferable materials to produce the phonogram-blank of said application.

One object of my present invention is to produce a strong, light, and economical core or backing for phonogram-blanks, over the surface of which a thin coating of material to be recorded is placed. This part of my invention consists in the use for the phonogram core or backing of hard rubber or ebonite, consisting of rubber or allied gums combined with sulphur by heat. This core or backing is coated with a thin surface of a sound-recording material, and the blank thereby produced possesses great strength, is light and economical, and is capable of withstanding rough usage; hence musical or other phonographic records or duplicates made on it may be handled or shipped without danger of breaking.

Another object of my invention is to provide the core or backing just referred to, which possesses great strength and abnormal expansion, with a material which shall have the same or substantially the same coefficient of expansion. I have found that the stearates of the metals possess practically the same coefficient of expansion as hard rubber or ebonite, and I propose to combine a stearate of a metal with a core or backing of hard rubber or ebonite to accomplish the object of this part of my invention.

A third object of my invention is to equalize any variation in the coefficients of expansion of hard rubber or ebonite and the stearates of the metals. This variation is likely to occur when different makes of hard rubber or ebonite are used, as this material when made by different manufacturers may have different coefficients of expansion. This I accomplish by combining with the stearate of a metal an oleate of a metal, by the use of more or less of which the coefficient of expansion of the stearate may be increased or diminished to correspond with the coefficient of expansion of the particular compound of hard rubber or ebonite used.

I prefer the phonogram-blank to be of the shape of a hollow cylinder with a tapering bore and a true cylindrical outer surface. The backing or core for the blank may be made in any suitable manner or by molding singly in the usual manner of making vulcanized india-rubber articles; or a hollow cylinder of the hard rubber or vulcanite may be made of length equal to a number of phonogram-blanks and subsequently cut to size and finished to form. The outer surface of the hard rubber or ebonite should be made rough to cause adherence of the recording-surface to be applied to it. The outer coating, which is preferably a material having the same or substantially the same coefficient of expansion as a stearate of a metal, but which may be of any other suitable sound-recording material, is preferably applied by dipping the cylinder into a bath of the melted material. When it is applied in this way, the surface may afterward be made true by turning it off in a suitable lathe after it has become cooled again. Instead of this, however, the external material may be applied by molding, the cylinder being placed in a mold which is slightly larger than the cylinder and the covering material poured into such mold around the cylinder, so that it will adhere thereto and will form a smooth and true surface without the necessity of turning it off. My experience has been, however, that the first-mentioned method is the less expensive.

When necessary, as above stated, an oleate of a metal may be added to the stearate in order to alter its expansion rate, the quantity varying according to the expansion rate required. For instance, if monostearate of soda is used the expansion may be increased by adding to it a small quantity of oleate of alumina. The proportion of the stearate and oleate used must be determined experimentally to suit the particular hard rubber or ebonite used.

The accompanying drawings illustrate a cylindrical phonogram-blank embodying my invention.

Figure 1 is a longitudinal section of the cylinder, and Fig. 2 an end view thereof.

A is the inner body or core, and B the outer surface of sound-recording material.

What I claim is—

1. A phonogram-blank composed of a base of hard rubber or ebonite and an outer covering of sound-recording material, substantially as set forth.

2. A phonogram-blank composed of a base of hard rubber or ebonite and an outer recording-surface of different materials having the same or substantially the same coefficient of expansion, substantially as set forth.

3. A phonogram-blank composed of a base of hard rubber or ebonite and an outer recording-surface of a stearate of a metal, substantially as set forth.

4. A phonogram-blank composed of a base of hard rubber or ebonite and an outer covering composed of a stearate of a metal and an oleate of a metal, substantially as set forth.

This specification signed and witnessed this 22d day of March, 1889.

THOMAS ALVA EDISON.

Witnesses:
W. PELZER,
RICHD. N. DYER.

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# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION** forming part of Letters Patent No. 430,274, dated June 17, 1890.

Application filed July 30, 1888. Serial No. 281,454. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 793,) of which the following is a specification.

My invention relates to phonogram-blanks for receiving a record of sound-vibrations and reproducing the same; and my object is to produce blanks having superior qualities for recording and reproducing such vibrations.

To this end my invention consists, mainly, in making such blanks, which are preferably of cylindrical form, of soap of the character hereinafter described. Said material may be employed alone or mixed with other materials, such as waxes, resins, or gums.

Insoluble soap may be formed of any metal or sometimes of an earthy oxide, like lime, in combination with any fatty acid. For my purpose, however, it is best to use lead, magnesium, or aluminium, combined with oleic or stearic acid, forming an oleate or stearate of the metal used. These compounds are preferred because of their superior amorphous quality. Of the metals named I especially prefer to employ lead, and especially to use a mixture of equal quantities of oleate and stearate of lead, the same being melted and poured into molds to form the cylindrical blanks.

The soap may be made according to the usual well-known methods.

What I claim is—

1. Phonogram-blanks made of metallic soap, substantially as set forth.

2. Phonogram-blanks made of lead soap, substantially as set forth.

3. Phonogram-blanks made of a mixture of oleate and stearate of lead, substantially as set forth.

This specification signed and witnessed this 14th day of July, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
A. W. KIDDLE.

(No Model.)

# T. A. EDISON.

## PHONOGRAM BLANK.

No. 430,570. Patented June 17, 1890.

Fig. 1.

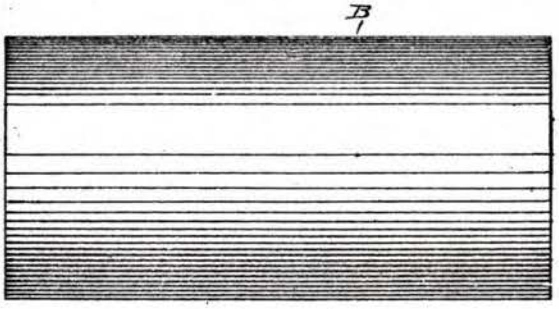


Fig. 2.

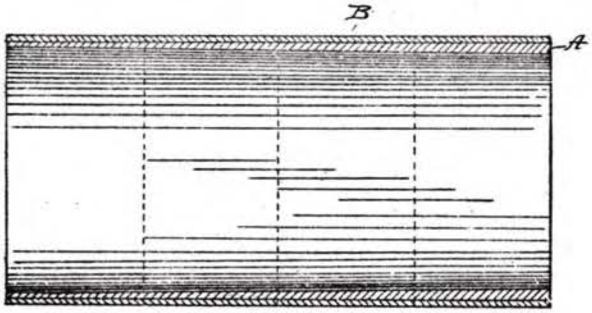
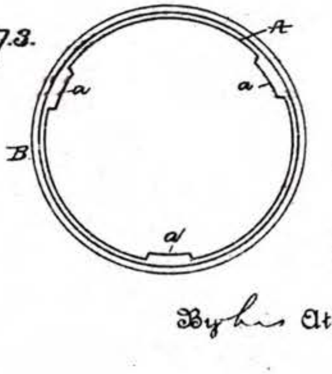


Fig. 3.



Witnesses
E. C. Rowland
William Pelzer

Inventor
Thomas A. Edison
By his Attorneys
Dyer & Seely

7, 1890.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

## PHONOGRAM-BLANK.

SPECIFICATION forming part of Letters Patent No. 430,570, dated June 17, 1890.

Application filed November 26, 1887. Serial No. 256,188. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 740,) of which the following is a specification.

The object I have in view is to produce an improved form of cylindrical phonogram-blank for my phonograph which will be durable and light, will be cheap in construction, and will retain its shape and size under varying atmospheric conditions. This I accomplish by constructing as a base for the phonogram-blank or recording-surface a cylinder of molded material, which is made plastic by heat or moisture. I prefer for this purpose plaster-of-paris, although I may use sealing-wax or a mixture of shellac and sand, sawdust, or other material, or asphalt. The plastic material—say plaster-of-paris—is molded in cylindrical form and allowed to set. when the wax-like phonogram-blank surface is placed upon it and the surface is turned down true in any suitable manner. The plaster-of-paris cylinder is given, preferably, a tapering bore, so as to be held by friction upon the tapering phonogram-cylinder of my phonograph. The phonogram-blanks will be made the full length of the phonogram-cylinder, and these full-length phonogram-blanks will also be divided into sections, so that the smaller sizes can be used for letters or memoranda of short length.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation of a phonogram-blank. Fig. 2 is a sectional view of the same, showing by dotted lines the divisions which will be made for producing sectional phonogram-blanks; and Fig. 3, an end view showing a modified form of the tapering bore.

A is the cylindrical base, made of molded plastic material—such as plaster-of-paris—or a material which is heated to be made plastic such as asphalt or sealing-wax. This cylinder has a tapering bore, as shown in Fig. 2, and a true cylindrical outer surface. The tapering bore may be formed by ribs *a*, as shown in Fig. 3. Upon this cylinder is placed a coating of wax or wax-like substance B, which forms the recording-surface.

I do not claim herein a phonogram-blank having a wax or wax-like recording-surface, or such a surface and a backing of tougher material, since these matters are covered by my application for patent, (Case No. 734,) Serial No. 252,964. Neither do I claim a cylindrical phonogram-blank having a tapering bore, since this will be made the subject of a separate application for patent.

What I claim is—

1. A phonogram-blank composed of a cylindrical base of molded material, having a tapering bore, and a recording-surface of softer material, substantially as set forth.

2. A phonogram-blank composed of a base of plaster-of-paris and a recording-surface of softer material, substantially as set forth.

This specification signed and witnessed this 22d day of November, 1887.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

nventor
A. Edison

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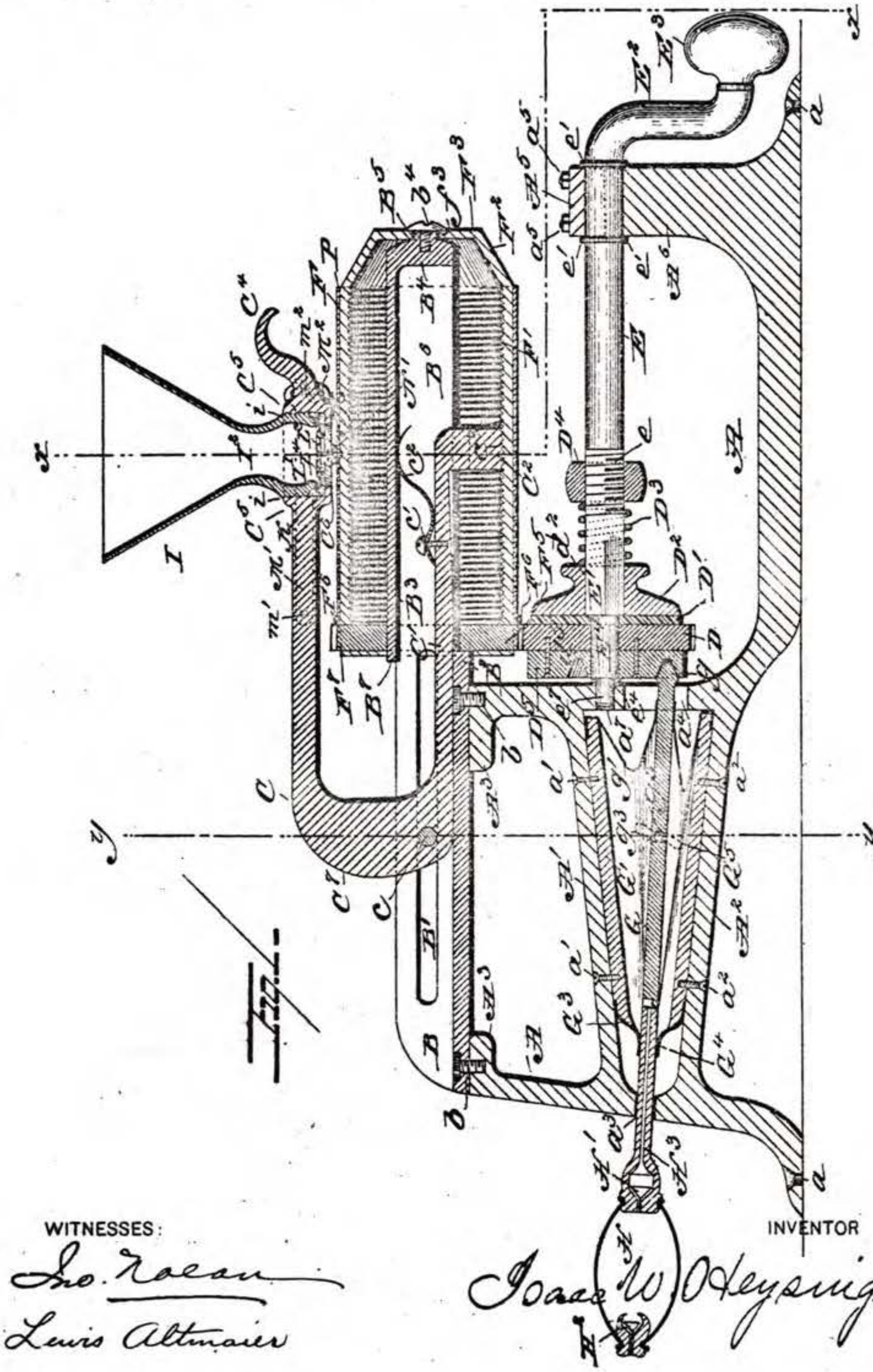
(No Model.) 3 Sheets—Sheet 1.

# I. W. HEYSINGER.

## PHONOGRAPH.

No. 440,155. Patented Nov. 11, 1890.



WITNESSES:

Jno. Nolan

Lewis Altmaier

INVENTOR

Isaac W. Heysinger.

(No Model.)

3 Sheets—Sheet 2.

# I. W. HEYSINGER.

## PHONOGRAPH.

No. 440,155.

Patented Nov. 11, 1890.

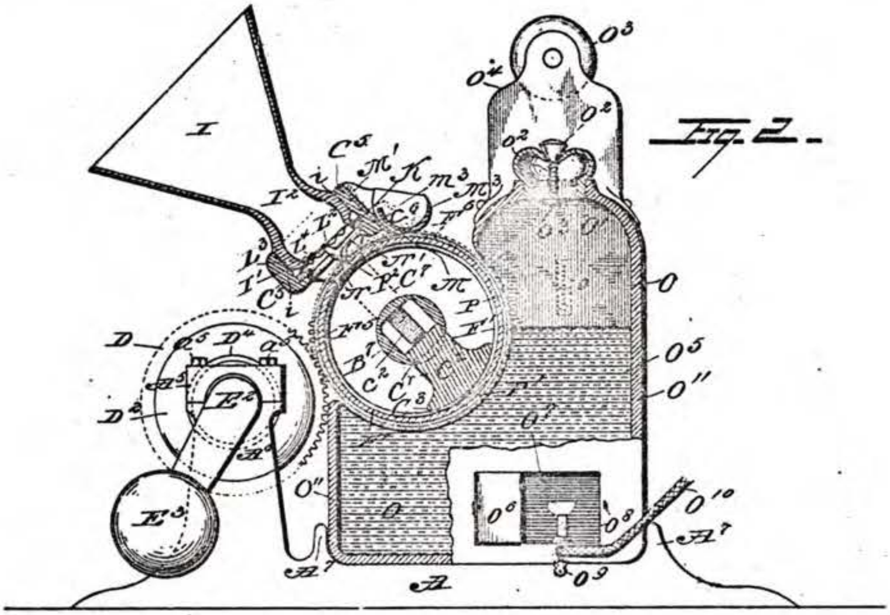
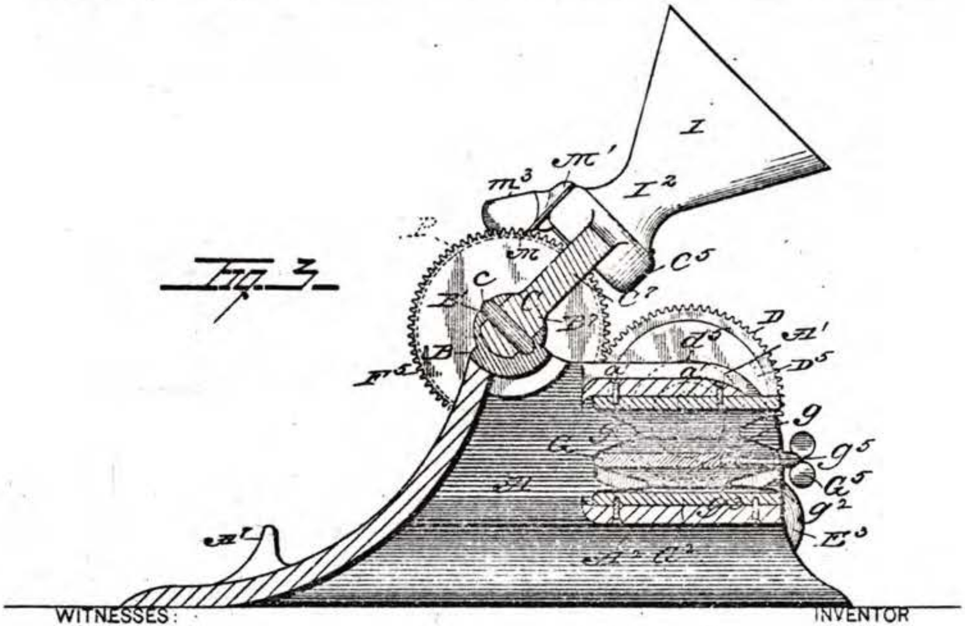


Fig. 2.

Fig. 3.



WITNESSES:

Jno. Nolan.

Lewis Altmaier.

INVENTOR

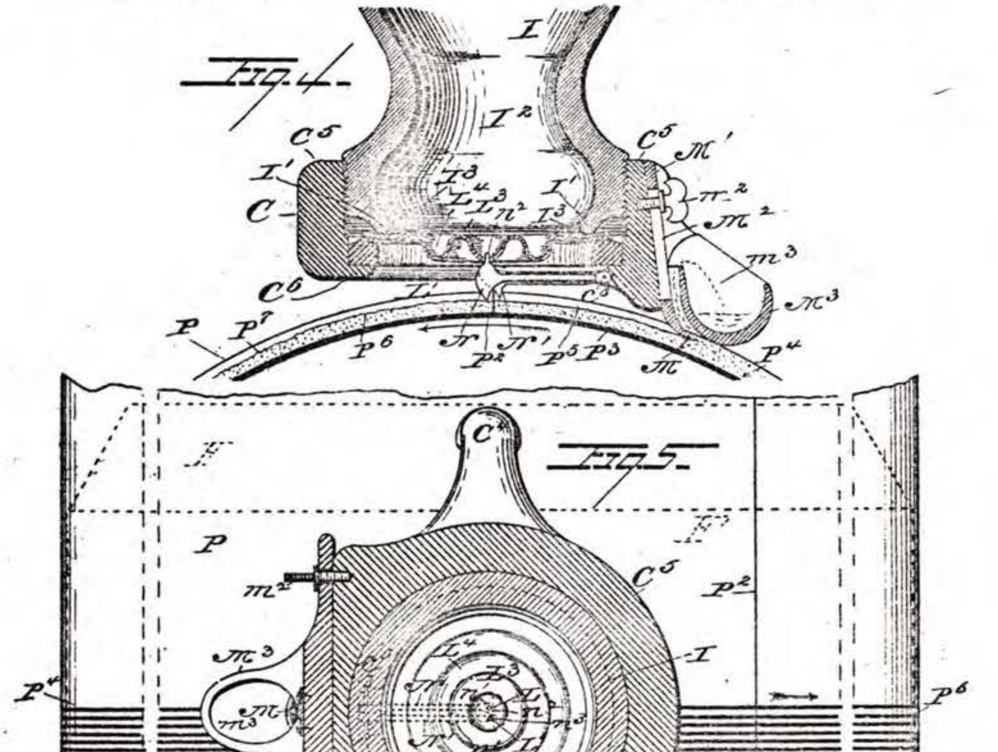
Isaac W. Heysinger

(No Model.) 3 Sheets—Sheet 3.

# I. W. HEYSINGER.

## PHONOGRAPH.

No. 440,155. Patented Nov. 11, 1890.



WITNESSES:

Jno. Nolan

Louis Altmaier

INVENTOR

Isaac W. Heysinger.

# UNITED STATES PATENT OFFICE.

ISAAC W. HEYSINGER, OF PHILADELPHIA, PENNSYLVANIA.

## PHONOGRAPH.

**SPECIFICATION** forming part of Letters Patent No. 440,155, dated November 11, 1890.

Application filed February 7, 1888. Serial No. 263,282. (No model.)

*To all whom it may concern:*

Be it known that I, ISAAC W. HEYSINGER, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Improvement in Phonographs, of which the following is a full, clear, and exact description, reference being had to the drawings accompanying and forming a part of this specification, in which—

Figure 1 is a side elevation of a phonograph embodying my invention, partially shown in section and the parts relatively somewhat displaced to more clearly show the construction, the heating-vessel O not being shown in the figure. Fig. 2 is a transverse vertical section along the dotted line $x\ x$ of Fig. 1, the parts being shown in proper relation as made for use. Fig. 3 is a transverse vertical section along the line $y\ y$ of Fig. 1, seen from the rear, the section shown in Fig. 2 being looked at from the front. Fig. 4 is an enlarged transverse vertical section of the funnel, diaphragm, grooving and indenting mechanism, and recording-tablet as in use, the same detached from the other parts of the machine. Fig. 5 is a top view, partly sectional, of Fig. 4. Fig. 6 is a view of the collapsible tablet expanded into a cylinder, as when placed in the machine for use. Fig. $6^a$ is the same flattened for mailing purposes, or for preservation. Fig 7 is a perspective view of a tablet collapsed and having its surface partly written over in the machine; and Fig. $7^a$ is a transverse sectional view of the written surface of Fig. 7, showing the grooves and lines of writing when two indenting-points are used.

The lettering in all the figures is uniform.

My invention relates to the construction of a phonograph or instrument for recording and reproducing the sounds of the voice, &c., by mechanical means, in which the words spoken are made to act upon a vibrating diaphragm, and by the movements thereof are indented upon a comparatively soft or yielding surface, to be subsequently reproduced by moving the said surface under and in contact with a stylus attached to the said movable diaphragm, or one similar thereto, in which certain improvements, as hereinafter described, enable the same to be accomplished more perfectly and the records to be preserved with greater security than with those now in use.

The first part of my invention consists in the use of a rotating cylinder, which carries the recording-surface supported upon a central bearing or rod extended along within the said cylinder and supported by the frame of the machine at one end only, so that one end of the cylinder is constantly free, so that the cylindrical tablet may be slipped over the free end of the cylinder or removed therefrom at any time without interfering with the other parts of the machine.

The second part of my invention consists in making this rotating cylinder hollow and providing its inner surface with an accurately-threaded screw from end to end, and against this screw-threaded surface engages a threaded block.

The third part of my invention relates to the use of a plow point rigidly secured to the arm or its attachments and not to the vibrating diaphragm.

The fourth part of my invention relates to the use of a tablet composed of a comparatively-hard substance adapted to protect the writing against rough usage, but capable of being made soft and plastic by the use of heat or chemicals, so that the tablet or surface is used in the machine in a soft and plastic state, but afterward when cooled or immersed in a chemical bath, or otherwise treated, it becomes hard and resistant and is capable of being put away for future use or sent through the mails without defacement or injury.

The fifth part of my invention relates to the use of a heater to be removably applied to my phonograph, in which heated surfaces are brought nearly in contact with the rotating tablet to soften it for the recording devices.

The sixth part of my invention relates to the means whereby I bridge over the split sides of my collapsible tablet when used in the machine. These split sides when the tablet is put upon the cylinder are brought very closely together, and the plow still further brings them together; but it often happens that when put on for reproducing the sounds there may be some indistinctness at this point. To prevent this and to improve the quality of the sound generally, I use a double indenting-stylus consisting of two points side by side.

The seventh part of my invention relates to the construction of the diaphragm and its surrounding parts. It is desirable to have this vibrating diaphragm quite sensitive to the undulations of sound, and for this purpose I make it of a thin, elastic, and resonant plate of metal or hard rubber or other equivalent material, and I form it with a series of circular concentric corrugations or waves with a flat outer rim, so that its elasticity and the mobility of its center are much increased, and whereby also the middle part is not only capable of being raised or lowered by the waves of sound, but also tilted from one side to the other somewhat as the sound vibrates at an angle to the axis of the diaphragm.

The eighth part of my invention relates to the means whereby I equalize the rotation of the recording-cylinder, so that the record will be characteristic and regular.

The detailed description hereinafter given will exhibit certain other matters of construction and arrangement which form a part of my invention, and which I shall illustrate by letters and reference to the drawings.

Referring now to the drawings, A is a frame-work of metal, adapted to stand upon a table and provided with screw-holes $a$ $a$ for attaching the same securely.

$A^6$ is an elevation, which terminates in a bearing for the driving-shaft E, seated at $A^5$. The shaft E is provided with flanges $e'$ $e'$, to prevent longitudinal motion of the same. The rear end $e^7$ of the shaft E is journaled into an upright extension of the base A at $a^7$, Fig. 1, and its forward end is provided with a handle $E^2$ and a hand-knob $E^3$ for operating the same, though gearing, weights, or springs may be used instead, if desired. The shaft E is screw-threaded at $e$, and a hand-nut $D^4$ is fitted thereupon.

$D^3$ is a coiled spring around the shaft E, which is compressed by the nut $D^4$ against the collar $D^2$, which slides to and fro along the angular part $E'$ of E, and rotates with it. The collar $D^2$, having an angular opening $d^2$ at its center, fitted loosely upon $E'$, is provided with a flanged rear surface, having a smooth face, and it bears against a leather disk $D'$, which in turn is forced against the smooth face of the spur-wheel D, which turns freely upon the cylindrical part $E^4$ of the shaft E. Attached to the rear side of the spur-wheel D and moving with it is a cam-plate $D^5$, having in its rear face, Figs. 1 and 3, a cam-groove $d^5$, circular in form and eccentric to the bearing of D. This cam-groove $d^5$ is tapered, so as to be narrower at the bottom.

$A'$ and $A^2$ are supports formed upon the frame A, to the inner sides of which are secured bellows-leaves $G'$ $G^2$, and between them is the vibrating leaf G, the bellows being formed and made air-tight by the leather or other folded sides $g'$ $g^2$, Figs. 1 and 3. The middle leaf G extends forward from the bellows and terminates in a conical pin or roller $g$, which enters the cam-groove $d^5$ and is controlled thereby.

$e^4$ is a little washer, or a number of washers, interposed between the journal $e^7$ of the shaft E and its seat $a^7$ in the frame-work A. As the action of the spring $D^3$ forces back the spur-wheel and cam against the washers $e^4$, a firm seat will be had in the cam-groove $d^5$ by the pin $g$, and as wear occurs one of these washers can be removed or a thinner one substituted to compensate for wear and prevent play or looseness.

The middle leaf G of the bellows is provided with an opening, preferably a slit $g^3$, connecting the two sections of the bellows, and a cock $G^5$ is inserted in the body of this middle leaf projecting at the side, Figs. 1 and 3, and provided with a thumb-piece, as shown. The stem of this cock is also perforated or slitted transversely, so that it may be rotated to close the slot entirely or regulate the size of the opening, as in a gas-burner cock, for instance. There is no other communication between the two sections of the bellows, and there is no external opening except where in rear is attached a small force-pump or rubber-ball syringe having valves closing outward, (see H H' $H^2$ $H^3$, Fig. 1,) by means of which air can be forced into the bellows and pressure maintained therein. The operation of this part of my invention is as follows:

When the shaft E is rotated and proper tension is made upon the collar $D^2$ by the nut $D^4$ acting through the spring $D^3$, the collar $D^2$ will rotate with the shaft E and carry around with it the leather disk $D'$, and this in turn will by its friction carry around with it the spur-wheel D and the cam-wheel $D^5$, attracted thereto by the screws $d^4$ $d^4$ or otherwise. As the cam-wheel rotates, the pin $g$ of of the bellows will rise and fall as the eccentric cam-groove $d^5$ changes its position with reference to the surrounding parts. As the pin $g$ rises and falls, the middle leaf G of the bellows will rise and fall and the contained air will be forced through the slot $g^3$ to and fro. If the cock $G^5$ is turned entirely off, the air cannot pass through the slot $g^3$ and the leaf G cannot rise or fall, and hence the cam-groove cannot change its position nor the spur-wheel D rotate, but the collar $D^2$ will slip upon the friction-disk $D'$. If the cock $G^5$ is turned a little way on, the motions will be slow, and they will increase in rapidity as the cock is turned on more and more. As compressed air is used, the reversal of direction of the leaf G will make no slip, the pressure being constant, so that a practically even and regular motion of the spur-wheel D will be secured so long as the motion of rotation of the shaft E is in excess of that of the spur-wheel D, and this relative speed can be regulated by the cock $G^5$.

While for illustration I set forth very clearly the specific construction, I do not confine myself to the use of a wind bellows or the specific friction devices or eccentric cam-groove shown, but use other mechanical equivalent for one or another part, as piston and cylinder, other fluid besides air, other frictional contact, and other mode of reciprocating the piston besides a cam-groove on the face-plate eccentric to its axis, and so, also, for the specific details of other parts of my invention.

The spur-wheel D gears with the spur-wheel $F^5$, which rotates the cylinder of my phonograph. The construction is as follows: A bar B, Figs. 1, 2, and 3, is attached at its rear end *b b* by screws or otherwise to an elevation of the frame-work A at $A^3$ $A^3$ and extend forward over the base parallel with the shaft E. This bar B is longitudinally grooved, the rear half $B^2$ cut out or open above, and the front half $B^6$ open below, and the front end $B^4$ is a solid head provided with a journal $B^5$. Along the rear half is a transverse slot B′ to admit a cross-pin *c*, forming a sliding bearing. At $B^3$, Fig. 1, a shoulder is formed, as shown. The cylinder F, which carries the plastic tablet is made hollow and has a funnel-shaped end $F^2$ to enable the tablet to be more readily applied; but this may be dispensed with in whole or in part, if desired. The end of the cylinder F is closed and is provided with a perforation $f^3$, through which passes the journal $B^5$ of the supporting-bar B, and the headed screw $b^4$, seated in the end of B, holds all in place, permitting rotation only. At the rear end of the cylinder F is attached the spur-wheel $F^5$, larger than the cylinder, preferably, and having a large central opening, which passes over the bar B, (made cylindrical to form a journal,) and the cylinder F is thus supported to rotate upon bearings at its opposite ends.

$B^3$ forms a shoulder against which the rear face of the spur-wheel bearing is supported, as shown. The cylinder projects from end to end free from other support, and a tablet can be applied or removed without disturbing the machine in any part. As the spur-wheel $F^5$ is geared to the driving spur-wheel D rotation of the shaft E will operate the cylinder F with a regular and uniform motion.

The hollow cylinder F is internally screw-threaded from end to end with an accurate and slow-pitched thread, so that the screw operates to the right side, and from the left when the handle $E^3$ is rotated in a right-hand direction.

C is a **U**-shaped arm, having its lower half extended along the slot in the bar B and its upper half extended over the upper surface of the cylinder F. At the bend $C^7$ in rear is a cross-pin *c*, which traverses the cross-groove B′, so that the **U**-shaped arm C may be slipped to and fro along the bar B, the upper part traversing along over the cylinder as the lower part traverses along within the cylinder. At the forward and upper end is a hook $C^4$, which enables the hand of the operator to seize it and move the arm C along the cylinder, as desired. The lower half of C is prevented from side motion by the sides of the bar B, as shown in Fig. 2. At the lower end of C is a downward projection $C^2$, expanded to form a segment of a cylinder, Fig. 2, and its lower surface screw-threaded to fit the threads of the internal screw F′ of the cylinder F. As the cylinder is rotated, the arm C will be seen to travel to and fro with a slow motion corresponding to the pitch of the screws F′ and $C^3$. A spring $c^2$, attached to the upper surface of the arm C within the cylinder, bears at its free end against the under side of the closed part $B^3$ of the longitudinal slot $B^6$ of the bar B, so that when the arm C is lifted by the thumb-piece $C^4$ the sectional screw $C^3$ will be raised to clear the internal threaded surface of F and the arm may be moved longitudinally along the cylinder, and whenever the thumb is released from $C^4$ the spring $c^2$ will bring down the free end of the arm C and cause the threaded surface thereof to again engage with the internal screw of the cylinder. The spring $c^2$ slides along the under surface of $B^3$, and a set-screw *c′* varies the strength of the spring and the resistance of the arm C, as may be desired.

The upper part of the arm C (see Figs. 4 and 5) is provided near the thumb-hook $C^4$ with an enlargement $C^5$, pierced with a circular opening, screw-threaded internally and provided with an inturned lip or flange $C^6$ at its lower side. Upon this inturned lip rests a ring of elastic india-rubber K, and upon this is laid, so as to close the opening in the arm C, a thin, resonant, elastic diaphragm L, supported at its edges by the elastic ring K. The conical funnel I, bell-shaped above, is provided with a neck $I^2$, and then is again expanded downwardly to face the diaphragm, and the outer surface of its lower part, which forms a ring *i*, is threaded to engage with $C^5$ and is screwed down upon the outer edge of the diaphragm L. A lip I′ is carried inward, Fig. 4, from the lower edge of the ring *i* to bear upon the top surface of the diaphragm slightly within the line upon which it rests over the elastic ring K, so that the funnel I may be screwed down in its socket, and by so doing the lip I′ will engage with the diaphragm and tend to force down the middle part of the same, so as to present a slightly-convex surface toward the cylinder; or this convexity may be presented upwardly, if desired, though I prefer to make it as shown. The object of this is to limit the vibration of the diaphragm somewhat in an upward direction, but give it the greatest freedom downwardly. I sometimes interpose a small disk or ring $I^3$ open at its center between the lower lip of I and the diaphragm L to prevent rattle; but if the ring *i* be well screwed down it will not be necessary. I show the ring *i* and the regulating-screw, which closes down upon and compresses the periphery of the diaphragm, formed integral with the funnel or cone I; but it may be made separate.

if desired. The funnel forms a convenient handle to operate it, as I have shown it in the figures.

To increase the amplitude of the vibrations of the diaphragm and to enable it to undulate laterally, I form my diaphragm with a series of concentric corrugations or circular bends $L^3$ $L^4$, which enable the middle of the diaphragm to be, so to say, drawn out or thrust in by the waves of sound, and also to wave or undulate from side to side or angularly as the waves of sound act upon the upper surface of the same more freely than when a plane surface is used. I graduate these corrugations for the special uses of the instrument and increase or diminish them in number, depth, or size, substituting one for another, as may be preferred.

I make my diaphragm of metal, or, preferably, of hard vulcanite, though chemically-prepared paper, cellulose, or other substances may be used, if preferred. As shown in the figures, the adjustment of the diaphragm is produced by screwing down the cone or funnel I, which compresses the elastic ring K and brings the diaphragm L more and more near to the cylinder F and its plastic covering P. Of course any form of diaphragm or compressing-spring may be used with these adjusting devices; but I prefer to use the corrugated diaphragms and rubber rings shown, for the reasons stated.

The recording-tablet of my phonograph is placed upon the cylinder F, and as the same is rotated the tablet passes under the diaphragm, and the plastic or yielding surface of the said tablet is capable of being scored or indented by a point or points attached to the arm C above the same. For this purpose (Fig. 4) I provide a plow-point M, which is attached to the farther side of the arm C immediately opposite the center of the diaphragm and it projects downward, so that its cutting or scoring point engages with the outer surface of the tablet as it passes beneath and cuts or plows a groove in the same. Since the arm C as the cylinder rotates is carried slowly along the cylinder this groove will form a spiral along the tablet corresponding to the internal thread of the threaded cylinder F′. As shown in Figs. 4 and 5, this plow-point is mounted upon the free end of an armlet M′, pivoted at $m'$ to the side of $C^8$, a lateral expansion of C. At its forward end the armlet M′ has a slot $M^2$ concentric with $m'$, in which is seated a thumb-screw $m^2$, so that the free end of the said armlet may be raised or lowered to cause the plow-point M to cut more or less deeply, and the thumb-screw $m^2$ being tightened up the cutter or plow-point will be fixed at a certain depth relatively to the arm C, and will cut at such depth at all times. As this plow-point takes up a shaving which would fall over upon the tablet, the upper part is curved backward, and a small disk $M^3$ is attached to the armlet M′ in rear of the cutter, into which the spiral of shaving produced by the cutter is directed (see dotted line $m^3$, Fig. 4,) and in which it is retained.

To the rear side of the under surface of $C^3$, immediately in front of the plow-point M, Figs. 4 and 5, I pivot my indenting levers or lever with a slightly-loose cross-pin. In the figures I show two levers side by side N N′, pivoted at $c^6$. The arrow upon the tablet shows the course of rotation of the cylinder, which is from the plow-point and toward the center of the diaphragm. These levers N N′ terminate under the center of the diaphragm L, and the said diaphragm is provided (see Fig. 5) with two small holes L L′, into which are inserted two small pins or stems $n^2$ $n^3$, attached to and forming a part of the levers N and N′, and these stems are securely attached to the diaphragm by solder, cement, or otherwise, and operate in conformity with the various movements thereof. Instead of these holes and pins in Fig. 2, I reverse the corrugations of my diaphragm and securely attach the pins of my levers, properly fitted, to the middle cup of my diaphragm; but in Figs. 4 and 5 the convexity of the middle corrugation extends downwardly, and these are perforated and securely support the pins of the indenting-levers N N′. The levers N and N′ (see Fig. 4) have a wedge-shaped stylus projecting downward directly under the pin $n^2$, having a slightly-rounded tip, and both sides of the wedge may have the same slope, or one may be more abrupt than the other. The parallel lever N′ is seated in the diaphragm very near to N, but has its wedge-shaped stylus somewhat in rear of that of its fellow, so that they will engage with the tablet upon parallel lines as the spiral of rotation is produced, but one slightly in rear of the other. The styluses of these indenting-levers, where they touch the surface of the tablet, are made slightly conical from side to side, as well as from front to rear, so that the indented line will be narrower at the bottom than at the top. The function of these styluses is not to cut but to ride over the surface of the prepared groove made by the fixed plow-point M with a varying pressure corresponding to the vibrations or undulations of the diaphragm, and each of these indenting-styluses traces an independent line, the one correcting the inaccuracies of the other or taking the record while the other is passing a break or interruption in the surface of the recording-tablet. For use with ordinary tablets a single stylus and lever may be used; but I prefer the double ones for the reasons stated.

When the shaft E is rotated, the cylinder F will rotate in a contrary direction and toward the operator. (See Fig. 2.) The arm C being raised and pushed back to the spur-wheel end of the cylinder F the screw-block $C^2$ $C^3$ will be brought into engagement with the internal screw F′. A tablet properly surfaced being placed over the cylinder C and pushed back to the rear its surfaces will be caught by the spring-clips $F^6$ $F^7$, which may be of any kind necessary, and the tablet will be prevented from rotating except with the cylinder. I prefer to use a cutting-edge for these clips, (see Fig. 5,) which will bite into the surface at the end of the tablet by the action of a spring $f^6$, so that a permanent mark will be made in the end of the tablet for a guide to reinsert the same in the same position. $F^7$ is made different in its marking-edge, Fig. 5, for this reason. As the writing commences back at the spur-wheel $F^5$ and moves forward toward the free end of the cylinder, there will be no special tendency upon the part of the tablet to slip to the front, and a slight end pull will hold it, while rotation independent of the cylinder is prevented by the cutting into the surface by $F^6$ $F^7$.

In Figs. 6, $6^a$, 7, and $7^a$ I show the tablet which I prefer to use in my machine, and which forms a part of my invention. $P^3$ represents a tubular foundation of flexible muslin, tough paper, or like substance. This flexible tube is provided with a homogeneous surface of gutta-percha, mixed with resin or like substance, which will make a compound hard and elastic at ordinary temperatures, but soft, plastic, and non-elastic at a temperature of from 110° to 140° Fahrenheit, or thereabout. This composition, applied to the flexible foundation, is then cut through along the axis of the tube at the two opposite sides from end to end down to the muslin or paper foundation, or nearly so. It is then surfaced off to present a surface of approximately even thickness. The tablet will have a surface of perhaps one-twentieth of an inch in thickness of a hard elastic composition, resistant to injury and capable of being flattened, as shown in Fig. 7, and may be readily sprung open and slipped over the cylinder of the machine to which it has been fitted, when the clefts $P'$ and $P^3$ will be closed and the tablet present a smooth surface. If removed from the cylinder when warm, it will flatten down, as shown in Fig. $6^a$, completely, and in either case may be put into an ordinary envelope and sent by mail like a common letter, or may be stored away or kept for future use in a small space.

I prefer to use gutta-percha in the construction of my tablet, because this substance contracts when heated, and this assists in forming a close connection between the tubular tablet and the surface of the cylinder to which it is applied. These tubes I form in considerable lengths, and, if preferred, I use them in the machine of a length to project beyond the free end of the cylinder, (see Fig. 5,) and when a record has been made of the required length I remove the tablet and when flattened cut off the surplus length, whereby I am enabled to economize in the material, and also save weight for mailing or other purposes. The portion cut off serves for another tablet, and so on until all is used.

I do not claim in this application the tablet, as hereinabove described, except in specific combination with certain operative elements of the phonograph; but have included the same in a separate application, Serial No. 270,897, filed April 17, 1888, the same having been divided from this application as originally filed.

The clip-marks produced by $F^6$ $F^7$, Fig. 5, show which end of the tablet is to be applied to the cylinder first and the position it is to occupy when the sounds of a record are to be reproduced from a previously-written tablet, and in such case I raise the plow-point, Figs. 4 and 5, upon its rear pivot $m'$, and fix it in a position out of contact with the cylinder by the set-screw $m^2$ in the slot $M^2$. This leaves a free surface of the cylinder and its covering-tablet to pass under the styluses $n$ $n'$, Fig. 5, which follow the same elevations and depressions in the hardened surface which they originally produced in the plastic mass. As I use this tablet for receiving indentations while soft and easily acted upon, and afterward reproduce the sounds when the surface is hard and resistant, the simplest means of producing this result is by the use of heat to render the surface soft, and afterward allowing a reduced or ordinary temperature to harden the same until again heated, and this permits the recorded surface when subsequently heated to be smoothed over, if desired, so as to obliterate the former writing and render it susceptible of use for other records.

I prefer to soften my tablet in the machine, and for this purpose I use a detachable heater, as shown in Fig. 2. This may be of solid iron, heated in a stove like a flat-iron; but I use in practice a hollow vessel filled with water, or nearly so. O represents such vessel, and is elongated, with straight sides, to slip in from the front of the machine between the guides $A^7$ $A^7$, and it is provided with an elevated side extending up partially around and over the cylinder, so that the tablet will revolve nearly in contact with this water-tank for a considerable part of its circumference, and especially just before it reaches the plow-point and indenting-points.

At $O'$ is a screw-nozzle for filling the tank, and a spring-guarded cone-valve $O^2$, opening upwardly, will prevent overheating, acting as a safety-valve. A handle $O^3$, attached to the tank by the pieces $O^4$, enables the same to be inserted or removed at will.

To enable me to ascertain and regulate the temperature of my heating device, I place a small thermometer $o$ at the front end, and I apply this heat by means of a small gas-jet $O^8$ in a chamber beneath and within the tank, closed by the door $O^6$, and supplied with gas through the tube $O^{10}$, controlled by the stop-cock $O^9$. Any lamp may be used instead; or the water may be poured in hot. I prefer to jacket the outside of this tank, as shown at $O^{11}$, Fig. 2, to prevent waste of heat. In using this device the tank is slipped in from the front end and extends along the cylinder from end to end. Being properly heated and the arm C raised and pushed back to the rear end, a tablet is pushed over the cylinder back against the rear end, where it is caught by the clips $F^6$ $F^7$. The heated tank softens the surface of the tablet at once, and the shaft E being rotated the plow-point M cuts a groove to a previously-adjusted depth in the surface of the tablet, forming a slow spiral as it traverses from rear to front. Fig. $7^a$ shows the form of the groove cut by the plow-point and has at the bottom thereof a slight elevation along the middle line, in each of which lateral grooves traverse one of the duplicate indenting-points $n$ $n'$. When the division-line $P^2$, Fig. 2, is reached, the forward indenting-point may drop somewhat at the cleft, but the rear one will carry the record perfectly, and so the front one will when the rear indenting-point is passing over $P^2$. When the record is complete, the tablet is pulled from the cylinder toward the free end, and after cooling is flattened down, the surplus clipped off, and the latter put into an envelope for mailing.

To reproduce the sounds of the record, the heating-tank O is removed, the tablet stretched open and slipped over the cylinder cold, the arm C pushed back, the tablet put under the clips $F^6$ $F^7$ in proper relation, and the plow-point M being raised the styluses traverse the same or similar lines as those produced by them previously and the record is reproduced in the same articulate sounds as those which produced the record originally.

I do not confine myself to the specific devices shown as regulating bellows or piston, driving mechanism, construction of frame, heating-tank, gear, diaphragm, indenting-points, plow-point, movable arm, &c., precisely as described, and which have been so described for clearness, but use such well-known modifications as are in use among mechanics and known in the arts without departing from my invention.

I do not in this application claim the phonograph-tablets herein shown and described as adapted to be used with the phonograph which forms the subject of my present invention, except when used in combination with the cylinder of my phonograph, as herein claimed, but have embodied the invention relating to the construction, composition, manufacture, and adaptation of the said tablets for use with phonograph-instruments for receiving, retaining, and reproducing the sound-records thereof in a separate application, filed by me in the United States Patent Office on the 17th day of April, 1888, Serial No. 270,897, the said divisional application for this part of my invention having been originally made a part of this application and fully claimed herein, but subsequently divided therefrom and embodied in a separate application, as hereinabove stated; but said tablets, as used in combination with the phonographic instrument, which forms the subject-matter of my present application and as a part of the same in use, together with the description and mode of use of said tablets, I have retained in this application, and have claimed said combination and use in combination with the phonograph described or with like instruments, claiming the said tablets generically in said divided application.

I do not broadly claim the use, in a phonograph, of a recording-tablet having a surface of plastic material adapted to be softened by heat to receive a record and subsequently hardened by exposure at ordinary temperatures, as the same has been fully described in long prior publications, among others in the British periodical *Engineering* of April 18, 1879, volume 27, page 327, in which it is stated that "the temperature is so arranged as to give the stearine surface the proper degree of hardness to insure the best results," and also in Letters Patent of the United States, No. 200,521, bearing date February 19, 1878, in which Letters Patent a similar substance is described at the bottom of the first column of page 2 thereof, but not claimed in said Letters Patent, and also in other publications of long prior date; but I confine myself to the subject-matter herein described and claimed.

Having now described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In combination with the cylinders of a phonograph, a tubular phonograph-tablet made in lengths longer than said cylinder, adapted to be applied so as to project from the free end of said cylinder beyond the forward bearing of the same when used and having a plastic surface, said tablet adapted to receive a spiral phonographic record commencing at its inner end and completed part way along the length of said tubular tablet, and the surplus adapted to be cut off for subsequent use as a separate tablet, substantially as described.

2. In a phonograph, in combination with a vibrating diaphragm and a recording-tablet moved with relation thereto, two parallel styluses pivoted to operate independently and both attached to the middle part of said diaphragm, one in rear of the other at its point of contact with said tablet, said styluses adapted to make a duplicate record upon said tablet, one in rear of and parallel with the other, substantially as and for the purposes described.

3. In a phonograph, in combination with a relatively-fixed arm capable of longitudinal movement, and a vibrating diaphragm, and a recording-tablet moved beneath the same, a plow-point attached to said fixed arm, adapted to cut a vertical groove in said tablet of a definite character, together with one or more indenting-styluses independent of said plow-point, said styluses attached to said vibrating diaphragm and adjusted to rest upon the bottom of said groove cut by said plow-point and

indent the bottom surface thereof as the said diaphragm vibrates and the said tablet is moved forward, substantially as described.

4. In a speaking-phonograph having a vibrating diaphragm, one or more indenting-styluses attached thereto and operated thereby and a tablet having a plastic surface moved under said diaphragm, a plow-point attached to the machine independent of said diaphragm, set at a suitable depth and adapted to cut a groove in the surface of said tablet preparatory to the action of said stylus or styluses, said stylus or styluses adapted to traverse said groove and form a record upon the freshly-exposed surface at the bottom thereof, substantially as described.

5. In a phonograph, the plow-point M, adjustable to the tablet P and independent of the diaphragm L, in combination with stylus N, operated by said diaphragm, said plow-point adapted to cut a vertical groove $P^6$ in the plastic surface of said tablet, and said indenting-point N adapted to travel along said groove and make a record along the bottom thereof as the said diaphragm vibrates and the said tablet is moved forward, said tablet having a surface soft and plastic when said record is made, but rendered hard and resistant subsequently, the whole so constructed that when said plow-point is raised out of contact with said tablet in a reproducing-phonograph said stylus L will be adapted to follow said hardened groove $P^6$ and traverse said record, reproducing the same as often as the same may be repeated, substantially as described.

6. In combination with the cylinder, diaphragm, indenting-stylus, and tubular tablet of a phonograph, the plow-point M, adapted to cut a spiral groove in said tubular tablet by the rotation of said cylinder preparatory to the action of the stylus along the bottom of said groove, and the dish $M^3$, adapted to receive the shavings $m^3$ as turned up and over from the said surface by the said plow-point, substantially as described.

7. In a phonograph, in combination with the arm C, supporting the diaphragm L and adapted to traverse from end to end along the cylinder F, and tablet P, applied thereto as the said cylinder is rotated, the armlet $M'$, attached to the side of the arm C, pivoted at $m'$ and having its forward end adjustable in height, together with the plow-point M, attached to the forward end of said armlet, and the set-screw $m^2$, adapted to fix the said plow-point at any desired elevation to cut into said surface P to any desired depth, or to enable the said plow-point to be raised to clear the said tablet P entirely, substantially as and for the purposes described.

8. In combination with the arm C, the armlet $M'$, provided with the plow-point M, and the receiving-dish $M^3$, said plow-point and dish adjustable in height upon said arm C, substantially as described.

9. In combination with the arm C, the adjustable plow-point M and transversely-rotating tablet beneath the same, having a plastic surface adapted to be grooved by the said plow-point, the vibrating diaphragm L, vertically adjustable to said tablet and adapted to be fixed at a height to conform to that of said plow-point, said diaphragm provided with a stylus extended down into the groove made by said plow-point and adapted to make a waved or indented path along the bottom of the same, said plow-point and said diaphragm adapted to be set at such relative heights that the said stylus will rest upon the bottom of said groove with any desired pressure as the said plow-point is set to cut more or less deeply, substantially as described.

10. In combination with the arm C, having circular opening $C^5$ and inwardly-flanged lip $C^6$, the vibrating diaphragm L, fitted within said opening $C^5$, and the elastic ring K, resting upon said flanged lip and supporting the outer edge of said diaphragm, together with a circular compressing-ring I, fitted within said circular opening $C^5$, bearing upon the diaphragm and adapted to be forced down upon said diaphragm and said elastic ring K to compress the said ring K and raise or lower the said diaphragm as said elastic ring is more or less compressed, substantially as described.

11. The combination of the arm C, having internally-screw-threaded circular opening $C^5$, internally-flanged lip $C^6$, elastic ring K, and vibrating diaphragm L, resting upon the same, with the externally-screw-threaded ring $i$, having circular lip $I'$, projecting inward and bearing upon said diaphragm within the line of support of said elastic ring K, and adapted to be screwed down upon said diaphragm and produce a downward thrust of the middle of the same, substantially as and for the purpose described.

12. In a phonograph, in combination with the internally screw-threaded and flanged opening $C^5$ $C^6$ and the diaphragm L, supported at its edge upon the flanged lip $C^6$, the sound-receiving funnel I, having an externally-screw-threaded ring $i$ at its lower part, adapted to be screwed down upon the free edge of said diaphragm to adjust and fix the same, substantially as described.

13. In a phonograph, the conical funnel I, having contracted neck $I^2$, narrower than the diaphragm L and expanded below the said contraction at $i$ to extend over the whole surface of said diaphragm, said funnel provided with a bearing-surface at its lower part to compress the edge of said diaphragm, in combination with a circular seat for said diaphragm and an internal lip adapted to support the free edge of said diaphragm, said supporting-seat, diaphragm, and funnel forming a single construction when thus united, substantially as described.

14. In combination with the arm having a circular opening $C^5$, internal lip $C^6$, diaphragm L, and screw-clamping ring $i$, the interposed

pad $I^3$, substantially as and for the purposes described.

15. The thin, resonant, vibrating, elastic, corrugated diaphragm L $L^3$ $L^4$, in combination with the supporting-holder $C^5$, clamp *i*, stylus N, attached to said diaphragm, and its indenting-point free to describe both a vertical and undulatory line upon said tablet, cylinder F, and recording-tablet P, adapted to move under said diaphragm and receive the record of said indenting-point, substantially as described.

16. In a phonograph, the diaphragm L, consisting of an elastic resonant plate of substantially equal thickness in its vibrating parts, securely fixed over the recording or reproducing tablet, said diaphragm having a series of concentric corrugations adapted to amplify the vertical vibrations and produce lateral and undulatory or gyratory vibrations as sounds act upon the same, in combination with a stylus attached to and operated thereby, said tablet presenting an extended surface at right angles to the axis of said stylus, and said stylus free to be operated by both the direct and undulatory movements of said diaphragm, or conversely, said tablet acting upon said stylus and said corrugated diaphragm to reproduce said vertical and undulatory vibrations thereupon, substantially as described.

17. In combination with the arm C, diaphragm-holder $C^5$ $C^6$, sound-funnel I, plow-point M, supporting-cylinder F, tablet P, secured to said cylinder and operated thereby, stylus N, and corrugated diaphragm $L^3$ $L^4$, substantially as herein shown and described.

18. In a phonograph, the vibrating diaphragm L, having two small central holes transverse to the path of the recording-tablet, in combination with two styluses N N′, bearing at their lower ends upon the recording-tablet beneath and provided above with a small pin $n^2$ $n^3$ upon each stylus and a shoulder beneath, said pins passing through said holes in said diaphragm, and said diaphragm supported upon said shoulders, substantially as described.

19. In a phonograph, a centrally-perforated diaphragm, in combination with one or more blunt indenting-styluses provided with upwardly-projecting pins entering said holes in said diaphragm, said holes and said pins accurately fitted to each other and adapted to convey from said diaphragm to the recording-tablet of said phonograph both vertical and undulatory movements thereof, substantially as described.

20. The blunt stylus N, seated at its upper end in the diaphragm of a phonograph, adapted to be acted upon by said diaphragm with a vertical or undulatory motion, in combination with an independently-supported plow-point acting upon the plastic surface of a recording-tablet in advance of said stylus and leaving a clean-cut groove in the surface of said tablet to be waved or indented without removal of material by said blunt stylus moving under pressure along the bottom of said groove, substantially as described.

21. In combination with the corrugated diaphragm $L^3$ $L^4$, parallel styluses N N′, seated therein, adjustable plow-point M, fixed independently of said diaphragm, rotating cylinder F, heater O, adapted to be placed nearly in contact with said cylinder, and the tablet P, having a surface $P^4$, adapted to be softened by the heat of said heater O, substantially as and for the purposes described.

22. In a phonograph, in combination with the heating-tank O, a tubular recording-tablet P, having a surface $P^4$, normally hard and adapted to be artificially softened by the heat of said tank O for receiving a record in the machine and subsequently hardened for reproducing the same, substantially as described.

23. In combination with a phonographic instrument and a recording-tablet adapted to be softened by artificially-produced heat for receiving a record, the detachable heating-tank O, provided with lamp $O^8$, nozzle O′, for filling said tank, safety-valve $o^2$, handle $O^5$, thermometer *o*, and fluid contents $O^3$, for heating said tablet, substantially as described.

24. In a phonograph, the heater O, having non-conducting jacket $O^{11}$ upon its exposed sides, substantially as and for the purposes described.

25. In a phonograph, the removable hollow heating-tank O, facing the recording-tablet and containing a heated fluid regulated in temperature and adapted to soften and render plastic the surface of a suitably-prepared recording-tablet when placed in said machine, substantially as described.

26. In a phonograph, the frame A, having guides $A^7$ $A^7$, cylinder F, and recording-tablet P, surrounding the same, in combination with an elongated internally-concave adjustable heating device adapted to be slid into the machine upon the frame A and between the guides $A^7$ $A^7$, and having a heated surface extended under and partially around the rear side of said tablet P, substantially as and for the purposes described.

27. In a phonograph, in combination with the recording-tablet thereof having a surface normally hard and adapted to be softened by heat to receive the record of the stylus of said phonograph, an artificially-heated body facing the free surface of said tablet when in place in the machine, substantially as and for the purposes described.

28. In a phonograph, in combination with the driving-shaft E, friction-gear D D′ $D^2$ $D^3$, cam $D^5$ $d^5$, governor G G′ *g′ g* $g^3$ $g^5$, spur-wheel D, geared to driving-wheel $F^5$, cylinder F, operated thereby, screw-thread F′, threaded block $C^3$, arm C, diaphragm L, stylus N, sound-receiving funnel I, the tablet P of a substance adapted to be softened by heat for receiving the impressions of said point N, and a detachable heater O, adapted to be applied to

said tablet and soften the surface of the same when acted upon by said indenting-point, substantially as described.

29. In a phonograph, the frame A, adapted to rest upon a table and having the elongated supporting-bar B attached at its rear end to said frame A and its forward end projecting to the front free of any support, in combination with a hollow cylinder F, surrounding the free end of said bar B, having front and rear bearings and journaled to rotate thereupon, said cylinder free of other support in front and having a recording-tablet surrounding said cylinder and detachable therefrom, together with a vibrating diaphragm and one or more styluses operating above said tablet to make a phonographic record upon the same when the said cylinder is rotated upon its supporting-bar B, said tablet tubular in form and applied to and removed from said cylinder at the free end thereof without interference with the said machine, substantially as described.

30. In a phonograph, in combination with the hollow rotating cylinder F, journaled at $B^7$ at its rear end upon the central bar B, and journaled at $B^5$ at its front end upon the said bar B, the supporting-bar B, its front end free and unsupported and its rear end rigidly secured to the frame A, said cylinder supported internally by the free portion of said bar B and adapted to rotate thereupon, said cylinder projecting forward, free from other support, adapted to receive a tubular tablet applied from the free end thereof without disturbance of the parts of said machine, together with a recording-diaphragm and indenting-stylus moved longitudinally along said cylinder, and means for rotating said cylinder and simultaneously moving said diaphragm longitudinally along the outer surface of the same, substantially as and for the purposes herein shown and described.

31. The bar B, having cylindrical bearing $B^7$, said bar slotted longitudinally in its rear half at $B^2$, said slot opening upwardly and slotted longitudinally in its front half at $B^6$, said slot opening downwardly and provided with a transverse groove B', extended transversely across slot $B^2$ and along the same from front to rear, and a journal $B^5$ at the free end of said bar B, in combination with a hollow cylinder F, supported at $F^3$ in front and $B^7$ in rear to rotate upon the projecting front half of said bar B, together with a U-shaped arm C, having an upper half extended forward over said cylinder F and a lower half extended forward within said hollow cylinder, said upper and lower halves parallel with each other, said lower half C' sliding longitudinally in said slot $B^6$, and the rear bend $C^7$ of said U-shaped arm C extended up through said slot $B^2$ and provided with cross-pin c, sliding longitudinally in said transverse groove B' and forming a pivoted support for the bend $C^7$ of said arm C, the whole so constructed that as said lower half of arm C is moved along within said cylinder F said upper half will correspondingly be moved along the outer surface thereof, substantially as and for the purposes herein shown and described.

32. In combination with the slotted bar B B' $B^2$ $B^6$ and hollow cylinder F $F^3$ $F^4$, rotating upon the free projecting part thereof, the U-shaped bar C C' $C^7$ c, provided with diaphragm L and recording mechanism supported thereupon at its upper end and a downwardly-projected block $C^2$ at its lower end, said block having a transversely-screw-threaded lower surface $C^3$, together with the internally-screw-threaded surface F' of said hollow cylinder F, said threaded surfaces $C^3$ and F' engaged with each other and adapted to move said diaphragm and adjacent mechanism along the upper surface of said cylinder as the same is rotated, substantially as described.

33. In combination with the cylinder F, bar B, arm C, and recording mechanism L N, the thumb-hook $C^4$ of said arm C, adapted to be seized by the hand to lift said recording mechanism from said cylinder, and at the same time raise the threaded block $C^2$ $C^3$ from threaded internal surface F' and slide the arm C to and fro along said cylinder without contact therewith, substantially as described.

34. In combination with the internally-threaded cylinder F and U-shaped arm C, pivoted at its rear in a longitudinal transverse groove B' of the bar B to permit motion to and fro of said U-shaped arm C along said cylinder, but prevent lateral motion of said arm upon said cylinder, the transversely-screw-threaded block $C^2$ $C^3$, attached to the lower free end of said arm C and adapted to engage with the internal screw F' of cylinder F, so that the rotation of said cylinder upon its axis will cause the said block to be screwed along to or fro within the said cylinder together with the diaphragm L and stylus N, supported upon the free upper end of said arm C and adapted to produce a phonographic record upon the surface of a soft tablet P, placed upon said cylinder F beneath said diaphragm L and in contact with said stylus N, and also adapted to reproduce the sounds of said record when said phonographic mechanism is applied thereto in a like manner, the whole so constructed that by raising the free end of the arm C upon the rear pivot c the recording or reproducing apparatus will be lifted clear of said tablet, and at the same time the threaded block $C^2$ $C^3$ will be raised from the screw-thread F' and the arm C may be pushed back or forth along the said cylinder F without obstruction, and when the free end of the arm C is permitted to drop the threaded blocks $C^2$ $C^3$ will engage with the screw F' and the recording or reproducing mechanism be again brought into contact with said tablet P, substantially as described.

35. In combination with the bar B, having

slot $B^6$, opening downwardly and closed above at $B^3$, the U-shaped arm C, having lower part C′ sliding longitudinally in said slot $B^6$, and spring $c^2$, attached to the upper side of C′ and impinging against the under surface of $B^3$, adapted by its tension to force down the forward ends of said U-shaped bar C, substantially as and for the purposes described.

36. The phonograph-cylinder F, mounted to rotate upon the bar B, said cylinder journaled upon said bar B and having wheel $F^5$ attached to and adapted to rotate said cylinder, and said wheel $F^5$, geared with and operated by wheel D upon driving-shaft E, said cylinder supported internally and projecting forward freely into space, said arm B attached to frame A at its rear end and by its projecting end extended through said cylinder F and supporting the same upon bearings $B^5$ $f^3$, in combination with an arm C, having a free end supported above said cylinder and adapted to be moved to and fro along the same, said arm provided with a recording diaphragm and stylus and at its opposite end with a screw-surface, and said cylinder provided with a screw rotating therewith, said screw of said cylinder and said screw-surface of said arm engaged with each other and adapted to slowly move the said diaphragm and stylus along said cylinder as the same is rotated upon its axis, substantially as described.

37. In combination with the frame A, driving-shaft E, spur-wheel D, opposite spur-wheel $F^6$, engaging therewith, hollow internally-screw-threaded cylinder F, recording-tablet P, slotted cylinder-supporting bar B, upon the forward end of which said cylinder rotates, U-shaped arm C, pivoted at its rear by the pin *c* in the transverse slot B′, said arm C having its lower half adapted to enter said hollow cylinder F and provided with transversely-screw-threaded blocks $C^2$ $C^3$ at its lower end to engage with threaded internal surface F′ of said cylinder and its upper half extended over said cylinder and provided with phonographic funnel I, diaphragm L, and stylus N, the whole constructed to operate substantially as herein shown and described.

38. In combination with the cylinder F and phonograph-tablet P, the duplicate holding-clips $F^6$ $F^7$, adapted to embed themselves in said tablet and hold the same in place upon said cylinder, said clips $F^6$ and $F^7$ having each a differently-formed embedding-surface to make a characteristic indentation for each clip and enable said tablet to be subsequently replaced upon said cylinder in the same position as before, substantially as described.

39. In a phonograph, the cylinder F, having a cylindrical surface of equal diameter to support the tubular tablet P, and a conical or tapered free end to enable said tablet to be expanded preparatory to forcing the same back upon the said cylinder, in combination with a vibrating diaphragm and stylus operated thereby, substantially as described.

40. In a phonograph, in combination with the rotating cylinder F, arm C, diaphragm L, stylus N, funnel I, and screw-block $C^2$, adapted to be operated by a screw rotated by said cylinder, and the plow-point M, mounted upon armlet M′, pivoted at $m'$ to arm C and its forward end adapted to be fixed at different elevations by the set-screw $m^2$, operating in the elongated slot $M^2$, substantially as described.

41. In a phonograph, in combination with the cylinder F, tablet P, arm C, screw-block $C^3$, attached thereto, screw-thread F′, rotated by said cylinder, and stylus N, a vibrating diaphragm L and funnel I, seated in the body of the said arm C and partaking positively of the motions of said arm and of the threaded block $C^3$ thereof, the whole so constructed that as the cylinder F is rotated the screw-thread F′ will move the said diaphragm L along the outer surface of said cylinder, and said diaphragm will be regulated vertically by the said screw-threaded block $C^3$ and threaded surface F′, irrespective of the variable thickness of the body of said tablet P upon said cylinder, substantially as described.

42. In combination with the driving-shaft E and flanged collar $D^2$, attached thereto and rotated thereby, the loosely-journaled spur-wheel D, rotated by frictional contact with said collar $D^2$ of said shaft E, together with the spur-wheel $F^5$, geared to and operated by said wheel D, said spur-wheel $F^5$ adapted to operate the phonographic cylinder F, substantially as described.

43. The combination of driving shaft E, having threaded section *e*, angular section E′, cylindrical part $E^4$, and journal $e^7$ with the screw-collar $D^4$, adapted to *e*, spring $D^3$, acted upon by $D^4$, sliding collar $D^2$, forced forward by $D^3$, loosely-journaled spur-wheel D, journaled upon $E^4$, and friction-pad D′, interposed between D and $D^2$, said spur-wheel held in place upon said cylindrical part $E^4$ and geared to and operating the phonographic cylinder F through spur-wheel $F^5$, substantially as described.

44. In combination with the driving-shaft E, loosely-journaled wheel D, operated by frictional contact from said driving-shaft, rotating cam-wheel $D^5$, cam-groove $d^5$, pin *g*, extending into and operated by the eccentricity of said cam-groove $d^5$ to move to and fro the reciprocating leaf-plate G, operated in an air-tight reservoir G′ $g'$, containing fluid, said leaf-plate perforated at $g^3$, or otherwise provided with a vent communicating with the said contained fluid upon each side of said leaf-plate to permit said fluid to change from one side of said leaf to the other in said air-tight reservoir with a regular motion as said leaf is operated by the rotation of said cam-wheel, and so regulate the velocity and movement of said spur-wheel D independently of a greater speed of said driving-shaft E, substantially as described.

45. In combination with the hand-knob $E^3$, shaft E, frictional contact D D′ $D^2$, spur-wheel D, closed bellows G G′ $g'$, variable ori-

fice $g^7$, adjusting-cock $g^5$, cam-wheel $D^5$, having eccentric cam-groove $d^5$, pin $g$ in said cam-groove, operating said bellows, the wheel $F^5$, cylinder F, longitudinally-moving arm C, vibrating diaphragm L, stylus N, and phonographic tablet P, the whole constructed to operate substantially as and for the purposes set forth.

46. In combination with the loosely-pivoted spur-wheel D, longitudinally-sliding friction-collar $D^2$, friction-pad $D'$, compressing-spring $D^3$, collar $D^4$, and driving-shaft E, the cam-wheel $D^5$, having eccentric cam-groove $d^5$ presented to the rear, said groove narrowed toward its bottom, together with tapered pin $g$, fitted in said cam-groove $d^5$ and prevented from rearward motion, said pin $g$ attached to and operating vibrating leaf-plate in regulating reservoir G $G'$ $g'$ filled with fluid, said spring $D^3$ operating to force back said cam-groove against said tapered pin and preserve at all times a closely-fitted bearing, substantially as described.

47. In combination with driving-shaft E, rearwardly-acting spring $D^3$, frictional contact $D^2$ $D'$ D, loosely-pivoted spur-wheel D, cam-plate $D^5$, secured thereto rigidly and having rearwardly-faced eccentric cam-groove $d^5$, and journal $e^7$, seated in bearing $a^7$ of frame A, and one or more washers $e^4$, adjusted in number or thickness to regulate the rearward thrust of said cam plate and groove against the conical pin $g$ of regulating apparatus G by said spring $D^3$, substantially as and for the purposes described.

48. In combination with the friction-gear $D^2$ $D'$ D, spur-wheel D, geared to and operating driving-wheel $F^5$, the bellows G $G'$ $g'$, adapted to reduce and regulate the excess of speed of rotation of said spur-wheel D by the movement of the perforated leaf-plate G in the air-tight reservoir of said bellows, said reservoir filled with air under pressure, and the force-pump H, provided with suitable valves $H'$ $H^2$ and adapted to be operated to compress air in said bellows and maintain said pressure therein, substantially as described.

49. In a phonograph, the combination of a driving-shaft, frictional contact-operating gear-wheel, said gear-wheel geared to and operating cylinder of said phonograph, said gear-wheel regulated by a pneumatic governor having a variably-adjusted perforated leaf-plate reciprocating in an air-tight compartment, the motion of said leaf-plate controlled by the adjusted passage of air through said perforation from one side of said leaf-plate in said compartment to the other, said perforation regulated in size by an external thumb-piece, said air maintained under suitable pressure in said compartment, the whole so constructed that when said driving-shaft is rotated at a greater speed than can be followed by the said reciprocating leaf-plate the said frictional contacts will slide upon each other and the excess of speed produce no effect upon the speed of rotation of said cylinder, substantially as described.

50. A mechanical sound recording and reproducing phonograph consisting of the driving-shaft E, frictional contacts D $D'$ $D^2$, friction-spring $D^3$, cam-wheel $D^5$, cam-groove $d^5$, bellows G $G'$ $g'$, pin $g$, operating the middle leaf-plate of said bellows, spur-wheel D, geared to and operating wheel $F^5$, hollow cylinder F, rotated by wheel $F^5$, slotted bar B, supported in rear and free in front, said cylinder F journaled upon said free end of said bar B, said cylinder F hollow and internally screw-threaded from end to end at $F'$, U-shaped arm C, having lower half $C'$ adapted to enter rear end of said hollow cylinder F and provided with transversely-screw-threaded block $C^3$, adapted to engage with said screw-thread $F'$, and the upper half of said arm C bent forward over the outer side of said cylinder F and provided above said threaded block $C^3$ with diaphragm L, stylus N, and funnel I, said arm C pivoted at its rear bend by a transverse pin $c$ in a longitudinal transverse slot $B'$ of said bar B and adapted to slide to and fro therein, said arm C adapted to be moved slowly along said cylinder as the same is rotated and to have its free ends in front raised simultaneously upon the rear pivot $c$ to clear the screw-thread $F'$ and cylinder F and its tablet P, said arm when thus raised adapted to be pushed to and fro along said cylinder without contact, and to engage with said screw-thread $F'$ and said tablet P when said free ends of arm C are allowed to drop into place, the whole constructed to operate substantially as herein shown and described.

51. In combination with the sound-concentrating funnel I, stylus N, and recording-tablet P, said recording-surface having a transverse position with reference to the axis of said stylus, and said stylus adapted to produce an indented record upon the flat surface thereof, the concentrically-corrugated diaphragm $L^3$ $L^4$, substantially as described.

52. In a phonograph, in combination with the circularly-corrugated diaphragm $L^3$ $L^4$, the stylus N, fixed to the center of said corrugations at $n^2$, the loosely-pivoted lever supporting said stylus, and plastic tablet P, the whole constructed to reproduce upon said tablet the transverse undulations of said diaphragm produced by laterally-acting waves of sound upon the corrugations of the same through said indenting-point, substantially as described.

53. A flexible tubular and collapsible tablet for phonographs, having a foundation $P^3$, of fabric or the like, a surface $P^4$ of composition adapted to be made soft and plastic and subsequently hardened, and a series of parallel spiral grooves $P^6$, cut to a certain considerable depth in said surface, and a record made by the stylus of a phonograph along the bottom of said grooves when soft and plastic and the same subsequently hardened, in combination with the reproducing stylus

and diaphragm of a phonograph adapted to reproduce the sounds thereof from the hardened record at the bottom of said grooves, substantially as described.

54. The tubular phonograph-tablet P, having transverse parallel grooves $P^6$ cut in a spiral in the surface thereof, said grooves divided at their bottom into two slighter parallel channels $P^8$ $P^9$, each of said channels having a phonograph-record produced by the same instrument at the same time, said duplicate records substantially alike, but one slightly in rear of the other, in combination with the diaphragm of a reproducing-phonograph and duplicate styluses, attached thereto, one slightly in rear of and alongside the other, said styluses adapted to follow and reproduce the said duplicate record simultaneously in articulate sounds, substantially as herein shown and described.

ISAAC W. HEYSINGER.

Witnesses:
M. B. FENNINGER,
P. O'DONNELL.

(No Model.)

# G. H. HERRINGTON.

## PHONOGRAPH.

No. 464,476. Patented Dec. 1, 1891.

Fig 1

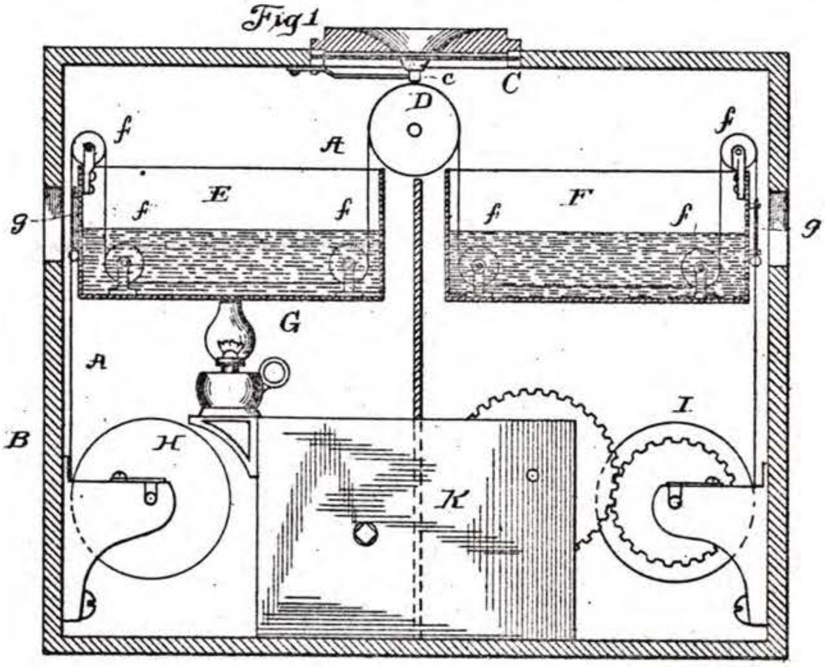


Fig 2.

Fig. 3.

Fig. 4

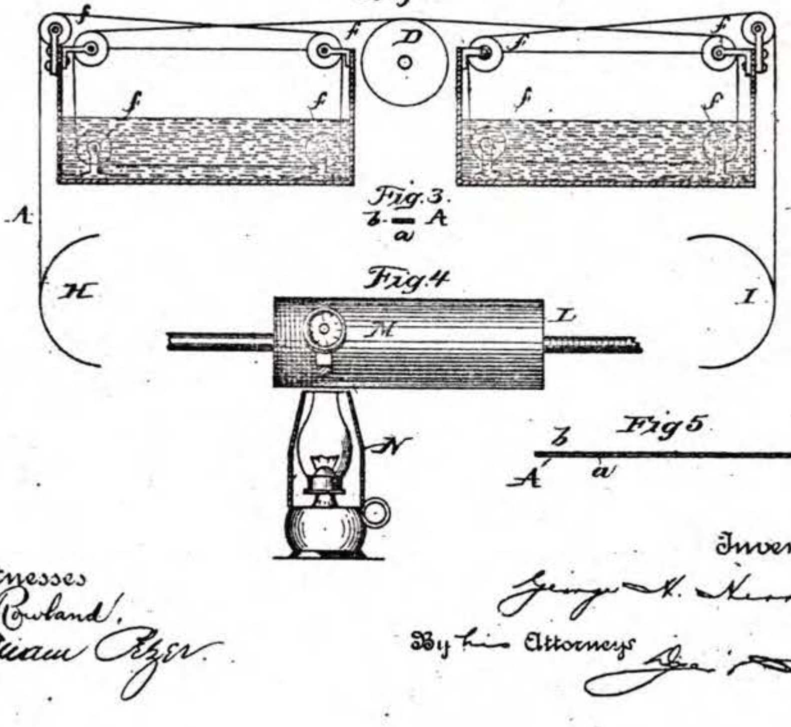


Fig 5

Witnesses

E. C. Rowland.

William Pezer.

Inventor

George H. Herrington

By his Attorneys

# UNITED STATES PATENT OFFICE.

GEORGE H. HERRINGTON, OF WICHITA, KANSAS

## PHONOGRAPH.

SPECIFICATION forming part of Letters Patent No. 464,476, dated December 1, 1891.

Original application filed September 11, 1886, Serial No. 213,278. Divided and this application filed August 22, 1888. Serial No. 283,459. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE H. HERRINGTON, of Wichita, in the county of Sedgwick, in the State of Kansas, have invented a certain new and useful Improvement in Phonographs, of which the following is a specification.

In my application filed September 11, 1886, Serial No. 213,278, of which this application is a division, is set forth and claimed a method of recording sound-vibrations, in which the recording medium is first rendered plastic, then passed under the vibrating point or needle of the recording-instrument while in such plastic condition, and finally allowed to harden to set the impression and produce a permanent record. My present invention relates to the apparatus for carrying this method into effect, which apparatus is shown and described, but not claimed, in the application referred to, I having been required by the Commissioner of Patents to embody the apparatus in a separate application.

In carrying my invention into effect I employ as a recording medium to receive the needle-indentations a material capable of being softened or made plastic and of afterward becoming hardened. I cause such surface to receive the indentations while in its softened or plastic condition, and it retains them when it becomes hard again. I prefer to employ a substance, such as boiled tar, pitch, resin, asphalt, dental wax, or similar hard substances or compounds which become plastic when heated, and by the employment of heat I soften to the desired degree this surface as it passes under the point of the diaphragm-needle, and then by cooling harden the surface to give the record permanency. The heat-affected medium is preferably applied as a coating to a suitable supporting-thread, strip, or sheet of metal, fabric, paper, or rubber, and this supporting-body is also preferably flexible, so as to be readily wound upon spools and passed around wheels or drums. The recording-surface may also be covered with an extremely thin metallic foil or be powdered to prevent sticking to the needle or to the wheels or rollers while in a plastic condition. The heat may be applied in any suitable way, and air, water, or steam may be used, the recording medium passing through a heating-chamber or over or around heating drums or rolls just before reaching the diaphragm-needle. The cooling may be effected by an air or water chamber, or by drums, or by other suitable means.

The phonograph may have a motor to move the recording medium under the point of the diaphragm-needle, and the same machine may, by the removal of the heating and cooling devices, be used to reproduce sound from such a record as has been described.

The same method and essentially the same apparatus can be employed for recording the movements of telephonic or telegraphic apparatus, so as to register messages sent by such instruments without departing from the spirit of my invention.

In the accompanying drawings, forming a part hereof, Figure 1 is a vertical section of a simple form of apparatus, illustrating the invention. Fig. 2 is a similar view of some of the principal parts of a modified form of apparatus. Fig. 3 is a cross-section of the recording-strip used with the apparatus of Figs. 1 and 2. Fig. 4 is a side elevation and partial section illustrating the application of the invention to the ordinary form of phonograph, and Fig. 5 is an edge view of a recording-sheet such as would be used with the apparatus of Fig. 4.

The recording strip A or sheet A′ has a flexible body *a*, of thin metal, fabric, paper, rubber, or other suitable material, provided with a surface *b* of the recording medium, such as boiled tar, pitch, resin, asphalt, hard dental wax, or other similar substance or compound, and this surface may or may not be powdered or covered with extremely thin metallic foil, as before set forth.

In the apparatus shown in Figs. 1 and 2 a suitable box or frame B is provided for supporting and inclosing the parts. The ordinary phonograph-diaphragm C is supported in an opening in the top of this box, and beneath the diaphragm is the needle *c*, mounted in the ordinary way. Directly below the needle *c* is the roller D, over which the recording-strip A passes in a suitable guiding-groove, this roller serving to bring the recording-strip into contact with the point of the diaphragm-needle. Heating and cooling chambers E and F are supported in the box B on opposite sides of the roller D, and are provided with wheels or rollers *f* for guiding and directing the recording-strip. A lamp G is shown for heating the chamber E and the recording-strip passing through it. Thermometers *g* are shown, by which the temperature of the chambers E F can be seen and regulated. Rollers H I carry the recording-strip, and a motor K gives the necessary movement to the strip.

In Fig. 2 the wheels or rollers *f* of the heating and cooling chambers are arranged so that in passing around them the recording-surface of the strip will not touch these wheels or rollers.

In Fig. 4 an ordinary phonograph-cylinder L is shown upon which the sheet A' is placed. The phonograph mouth-piece is shown at M. A lamp N is shown for heating the recording-surface of the sheet to a plastic condition as it passes under the diaphragm-needle. The recording-surface is cooled by the air as it passes from the influence of the lamp.

The recording medium is made as plastic as possible without injury as it passes under the diaphragm-needle, thus giving the greatest possible freedom of movement to the diaphragm, while the subsequent cooling by the atmosphere or artificially gives the recording medium a permanent hardness. When a message or communication has once been registered on the strip or sheet by a phonograph, telephone, or telegraph instrument, it can be repeated any number of times and can be handled without injury to the impressions and sent to any distant point to be repeated without the aid of a skillful operator at that point.

By removing the lamp or other heating medium the same apparatus may be employed to reproduce the sounds by running the strip or sheet under the diaphragm-needle, so that its point will follow the sound-wave impressions or indentations.

It will be understood that I do not limit myself to the use of any particular material or compound as a recording medium, as any material or compound may be employed which when heated is sufficiently yielding or plastic to readily receive impressions and which will set and retain the impressions when cold.

What I claim is—

1. The combination, with a phonograph diaphragm and needle, of a traveling recording medium composed of a material or compound capable of being made plastic by heat, and means for heating and cooling such medium, substantially as set forth.

2. The combination, in a phonograph, of a strip or sheet phonogram-blank having a flexible body and a covering or surface of a material or compound capable of being made plastic by heat, and means for heating said material or compound, substantially as described.

3. The combination, with a phonograph diaphragm and needle, of a traveling recording strip or sheet having a flexible body and a surface of a material or compound capable of being made plastic by heat, and means for heating and cooling the surface of such strip or sheet, substantially as set forth.

4. The combination, with a phonograph diaphragm and needle, of a traveling recording medium capable of being made plastic by heat, a motor for moving such medium, and means for heating and cooling such medium, substantially as set forth.

This specification signed and witnessed this 2d day of August, 1888.

GEORGE H. HERRINGTON.

Witnesses:
JOHN P. ROGERS,
A. T. OWEN.

## Correction in Letters Patent No. 464,476.

It is hereby certified that Letters Patent No. 464,476, granted December 1, 1891, upon the application of George H. Herrington, of Wichita, Kansas, for an improvement in "Phonographs," were erroneously issued to said Herrington as sole owner of the invention; that said Letters Patent should have been issued to said *George H. Herrington and Edward H. Johnson, jointly*, each being owner of one-half interest, as shown by the record of assignments in this Office; and that said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 8th day of December, A. D. 1891.

[SEAL.]

CYRUS BUSSEY,
*Assistant Secretary of the Interior.*

Countersigned:
W. E. SIMONDS,
*Commissioner of Patents.*

(No Model.)

# T. A. EDISON.

## PROCESS OF DUPLICATING PHONOGRAMS.

No. 484,582. Patented Oct. 18, 1892.

Fig. 1

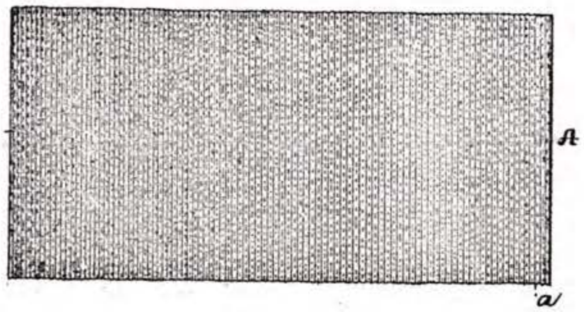


Fig. 2.

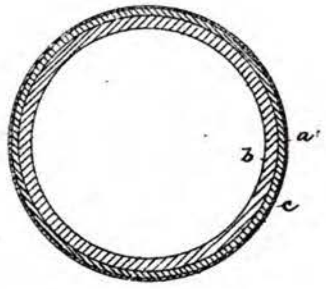


Fig. 3.

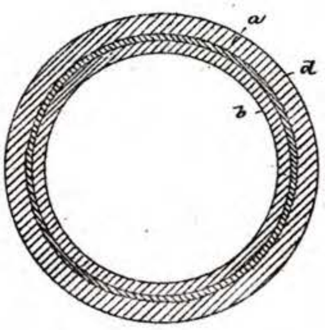


Fig. 4.

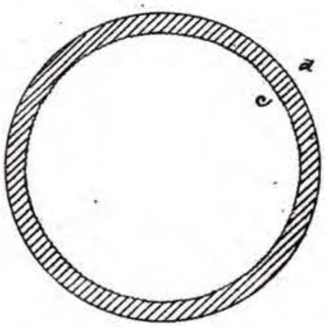


Fig. 5.

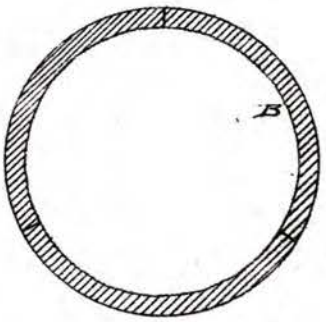


Fig. 6.

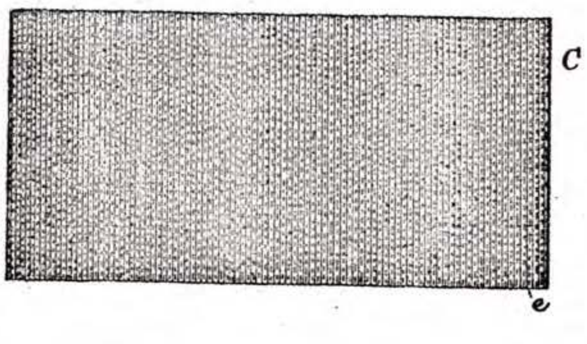
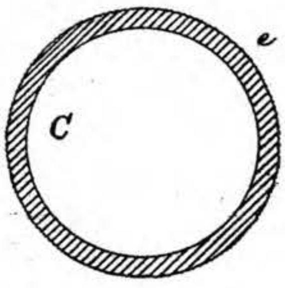


Fig. 7.



Witnesses
E. C. Rowland
William Pelzer

Inventor
Thomas A. Edison,
By his Attorneys Dyer & Seely

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

## PROCESS OF DUPLICATING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 484,582, dated October 18, 1892.

Original application filed January 5, 1888, Serial No. 259,895. Divided and this application filed January 30, 1888. Renewed March 30, 1892. Serial No. 427,011. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Process for Duplicating Phonograms, (Case No. 751,) of which the following is a specification.

The object I have in view is to produce a practical process for the duplication of phonographic records, so that the new art of phonographic publication can be established. Generally I propose to construct a suitable matrix, preferably in metal, and by its use mold duplicate phonograms with the phonographic records thereon, such phonograms or the surface thereof being preferably constructed of a material too hard for the satisfactory indentation thereof by the phonograph-recorder; but the duplicate phonograms may be made of a softer material. For the construction of the matrix I employ the process of vacuous deposit described in my application, Serial No. 118,942, filed January 28, 1884. The original phonogram is preferably constructed with a surface of wax or a similar material. This is placed in a suitable phonograph and the phonographic record produced thereon. The phonogram so impressed with the phonographic record is placed in a high vacuum, in which an electric arc, continuous or discontinuous, is produced between electrodes of metal or in which metal vapor is otherwise produced. The electric arc produces a vapor of the metal of which the electrodes are composed, which vapor or a metallic vapor otherwise produced within said chamber is deposited on the indented surface of the phonogram, forming a layer of metal thereon, which follows accurately all the indentations of the record, however minute, owing to the highly-comminuted condition of the metal deposited. The phonogram while the deposit is taking place in the vacuum-chamber is revolved slowly by a suitable power-connection, and this is especially necessary when the form of the phonogram is cylindrical, which it preferably is. The vacuous deposit is continued until the layer of metal is sufficiently thick, when the covered phonogram is removed from the vacuum-chamber and is further covered by a more rapid process to give strength and body to the covering. A further covering of metal may be produced by electroplating a metal upon the vacuous deposit in the usual manner of electroplating, or the vacuous deposit may be backed up by casting upon it type-metal or other metal or alloy having a lower fusing-point than the vacuous deposit, or this may be done after electroplating upon the vacuous deposit, or the vacuous deposit may be backed up by a a cement or gum or by plaster-of-paris; but a metal backing is preferred. The material of the original phonogram is then dissolved off of the metal covering, leaving in the case of cylindrical phonograms a hollow metal cylinder or one internally faced with metal, carrying the phonographic record in relief upon its inner surface. This metal cylinder is then split longitudinally by a very thin saw into a number of parts—say, for illustration, three parts—which are suitably mounted upon levers, so that a mold is formed, which can be closed to receive the material to be molded and opened to permit of its being taken out. The duplicate phonograms are produced by means of this mold by pouring therein and preferably around a suitable core placed in the mold suitable substances, such as wax or wax-like material, resin, or plaster-of-paris, the material being preferably too hard to be satisfactorily indented by the phonograph, or the duplicate phonograms may be made by taking sheets of smooth material, like waxed paper or tinfoil, and pressing them upon the surface of the mold by a plunger or otherwise, the sheets being afterward backed up by a wax, resin, or cement. The latter way of making the duplicate phonograms is especially applicable to flat-surface phonograms, although it may be used for phonograms with cylindrical surfaces. The production of the first layer of metal upon the phonograph-record by means of the vacuous deposit has great advantages over doing this by electroplating. In electroplating the wax-surface must first be covered by plumbago or gold-leaf or silver salts reduced by chemical reagents in order to form a conducting basis for the plating. The plumbago and gold-leaf do not bring out the fine vibrations and produce rough reproductions while the silver salts do not run well on the wax surface. The vacuous deposit, however, adheres uniformly to the wax surface and reproduces the record with great perfection.

The invention is illustrated for convenience in connection with a cylindrical phonogram.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation of an original phonogram; Fig. 2, a cross-section of the original phonogram with a thin vacuous deposit thereon; Fig. 3, a view similar to Fig. 2, with a further backing; Fig. 4, a view the same as Fig. 3, with the original phonogram dissolved out; Fig. 5, a sectional view of the divided mold or matrix; Fig. 6, an elevation of a duplicate phonogram produced by the mold, and Fig. 7 a cross-section of such duplicate phonogram.

A is the original phonogram, having a relatively-soft wax or wax-like surface *a* and the backing of harder material *b*, or it may be entirely of wax. The phonographic record is produced upon the surface *a*. The metallic vacuous deposit is shown at *c*, and the further backing, preferably of metal, is shown at *d*.

B is the divided mold, produced as has been stated and having the phonographic record in relief.

C is the duplicate phonogram, produced by the mold and having a surface *e*, indented with the phonographic record and preferably of harder material than could be practically or satisfactorily indented directly by the phonograph.

My invention herein is limited to constructing the matrix or mold by covering the phonograph-record by a vacuous deposit.

The broad invention of duplicating phonograph-records and of producing matrices for that purpose, not limited to the use of the vacuous deposit as a step in the process of reproducing the phonographic record or constructing a matrix for that purpose, is not claimed herein, such broad subject-matter being covered by an application for patent filed by me January 5, 1888, Serial No. 259,895, of which this specification is a division.

What I claim is—

1. The process of forming a matrix or mold for the duplication of phonographic records, consisting in covering the phonograph-record with a deposit of metal by vaporizing metal in a vacuum in which the record is placed, substantially as set forth.

2. The process of forming a matrix or mold for the duplication of phonographic records, consisting, first, in indenting the original record on a phonogram; second, covering the recording-surface of such phonogram with a deposit of metal by vaporizing metal in a vacuum in which such phonogram is placed, backing up such deposit to give it strength, and then removing the original phonogram, substantally as set forth.

3. The process of forming a matrix or mold for the duplication of phonographic records, consisting, first, in indenting the original record upon a phonogram having a wax-like surface; second, covering the recording-surface of such phonogram with a deposit of metal by vaporizing metal in a vacuum in which such phonogram is placed, backing up such deposit to give it strength, and then removing the original phonogram, substantially as set forth.

4. The process of duplicating phonograms carrying a phonographic record, consisting, first, in indenting the original record upon a phonogram; second, constructing a matrix or mold of such original record by depositing thereon a coating of metal by vaporizing metal in a vacuum in which the record is placed, and, third, producing duplicate phonograms from such matrix, substantially as set forth.

This specification signed and witnessed this 17th day of January, 1888.

THOS. A. EDISON.

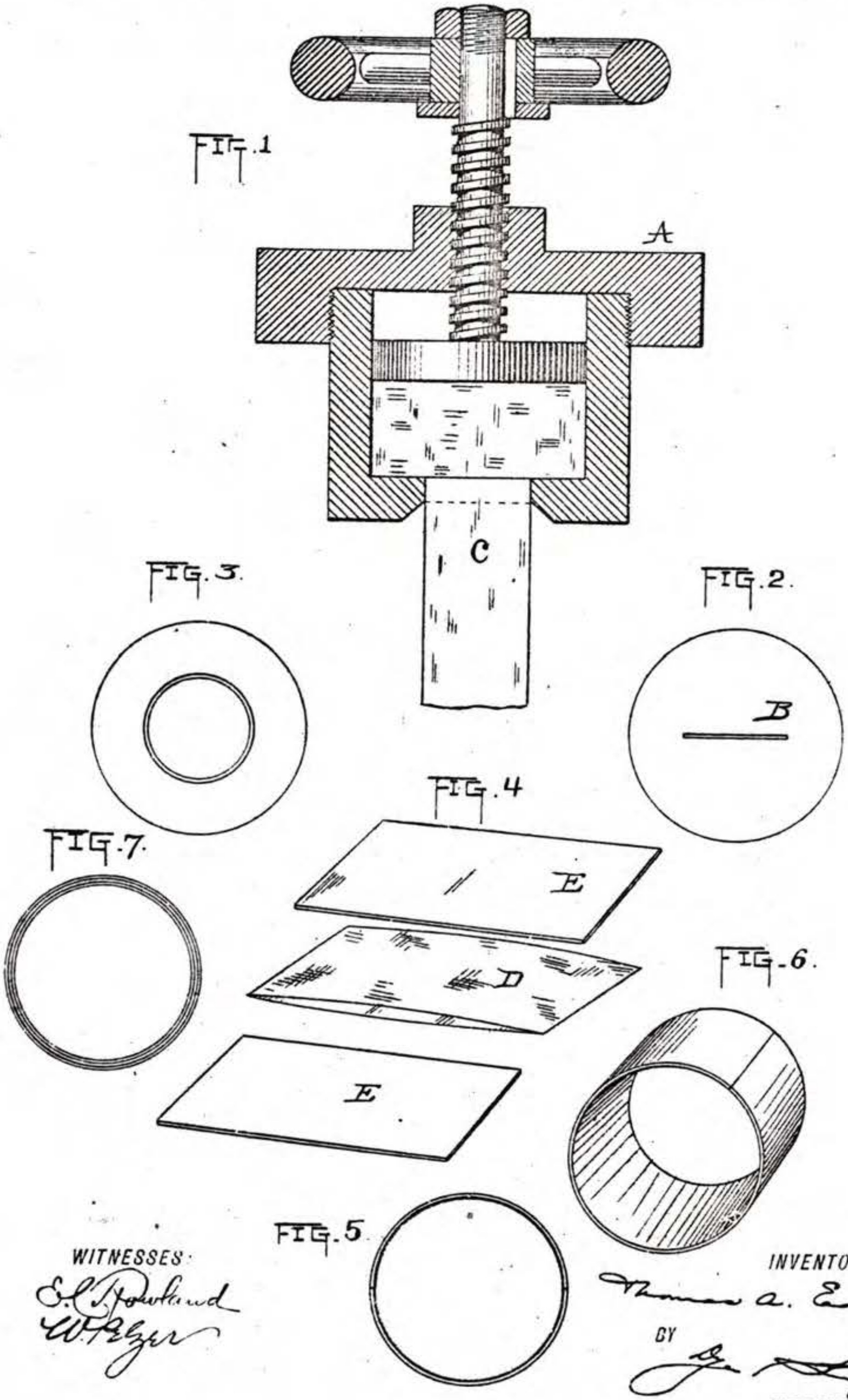
Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

# T. A. EDISON.

## PHONOGRAM BLANK.

No. 488,191. Patented Dec. 20, 1892.



WITNESSES:
E. C. Rowland
W. Pelzer

INVENTOR
Thomas A. Edison
BY
ATTORNEYS.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION forming part of Letters Patent No. 488,191, dated December 20, 1892.**

Application filed January 19, 1889. Serial No. 296,876. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 812,) of which the following is a specification.

The object of this invention is to provide phonogram blanks or surfaces for receiving sound records in the phonograph, which shall be of a convenient and simple form and can be cheaply and readily manufactured, and which will be adapted to be conveniently packed in boxes and inclosed in envelopes for transmission by mail.

The main feature of the invention consists in the use of thin flexible sheets of wax or wax like material, which sheets either by themselves or combined with backings of other suitable material, are used as the recording mediums in phonographs. I may form such sheets of plastic flexible material, by rolling or pressing such material into sheets, but I prefer to produce them by forcing the material through an aperture of the desired form in a press. The sheets thus formed may be used in a variety of ways. Such sheets may themselves form flat recording surfaces for the phonograph, or they may be attached to backings of paper or similar flexible material and used as flat recording surfaces, or they may be formed into cylinders, either with or without an internal backing of paper or like material, or they may be placed upon rigid cylinders and used in the phonograph, or used in various other ways.

There are many compounds of wax or wax like material which may be employed for the purposes of my invention. What I prefer to use is a mixture of asphalt with Japan wax or pitches made from the distillation of fatty oils or combinations of fatty acids, any of which materials are equivalents of wax for the purposes of this invention. The proportions of the different substances will vary as the conditions differ and as sheets of different degrees of flexibility are required. Beginning with the asphalt alone, which is brittle even in thin sheets, the flexibility may be brought to any desired degree by adding more or less of the Japan wax or equivalent flexible substance.

My invention is illustrated in the accompanying drawings:

Figure 1 illustrates the use of the squirting press for forming the thin sheets. Figs. 2 and 3 are bottom views of different forms of the press; Fig. 4 shows the preferred method of placing such thin sheets upon a paper backing; Fig. 5 illustrates a cylinder thus formed; Fig. 6, a cylinder formed from the plastic sheet alone; and Fig. 7 shows a cylinder formed of a number of plastic sheets which are intended to be torn off as they are used.

A quantity of the material, such as above described, is placed in the press A in the bottom of which is usually a slot or elongated aperture B, (Fig. 2.) The material is raised to such temperature as will insure its easy passage through the aperture, and the pressure is then applied, and the material forced in the form of a thin sheet C through the aperture, as illustrated in Fig. 1. I prefer to allow it to pass directly into water, so as to set it immediately, and prevent distortion while it is in a heated condition. After it is dry, it may be coated with fine powder, such as talc or kaolin, to prevent the surface from adhering to other objects, and the strip which has come from the press is then cut up into sheets of the required size. These sheets may, as above stated, be used in many different ways. The sheet may be bent around a forming cylinder and the ends overlapped and pressed together, the surplus material being removed by a cutting or scraping tool, or preferably the ends are made to meet and are joined together by the application of a heated wire or by the addition of a small amount of the softened material along the joint. By this means cylinders like that shown in Fig. 6 are formed. Instead of this however, a sheet of thin paper may be cut to the proper size and formed into a cylinder with its edges joined, and this cylinder is then collapsed into a flat double sheet as illustrated in Fig. 4, the collapsed cylinder being shown at D. The double sheet D is placed between two sheets E E of the flexible wax like material and the whole is submitted to pressure. The backs of the sheets E, or the sheet D being previously moistened with a solvent of the flexible material, such as benzol, the sheets E are thus made to adhere firmly to the sheet D, whereby a collapsed phonogram blank is formed, which can be drawn out into a cylinder and placed upon the cylinder of the phonograph, or upon a false shell placed thereon. A cylinder drawn out into form for use is shown in Fig. 5.

Instead of a backing of paper, the thin flexible sheets formed into cylinders like Fig. 6 or used in sheet form, as flat recording surfaces, may be covered with a varnish, such as a solution of a suitable gum, like gum balata, in a solvent such as bi-sulphide of carbon. A number of sheets of this character can be formed into a composite cylinder as shown in Fig. 7, the different layers, one of which is affected at a time by the phonograph recorder, being torn off as they are used.

The squirting press may have an annular aperture as shown in Fig. 3, whereby the material may be forced out in the form of cylinders instead of in sheets.

What I claim is:

1. A collapsible phonogram blank consisting of a cylinder of flexible material with separable sheets of flexible wax or wax like material placed thereon, substantially as set forth.

2. A composite phonogram blank, consisting of two or more separately removable layers of recording material, each layer being of such thickness that a record impressed on one layer will not be transmitted to a succeeding layer substantially as set forth.

3. A composite phonogram blank, consisting of a cylinder of two or more separately removable layers of recording material, each layer being of such thickness that a record impressed on one layer will not be transmitted to a succeeding layer substantially as set forth.

4. A phonogram blank having in combination super-imposed separable layers of flexible wax or wax like material, substantially as set forth.

This specification signed and witnessed this 10th day of January, 1889.

THOMAS A. EDISON.

Witnesses:

H. W. SEELY,

W. PELZER.

(Model.)

# J. E. WASSENICH.

## TABLET FOR RECORDING SOUND VIBRATIONS.

No. 505,910. Patented Oct. 3, 1893.

Fig. 1.

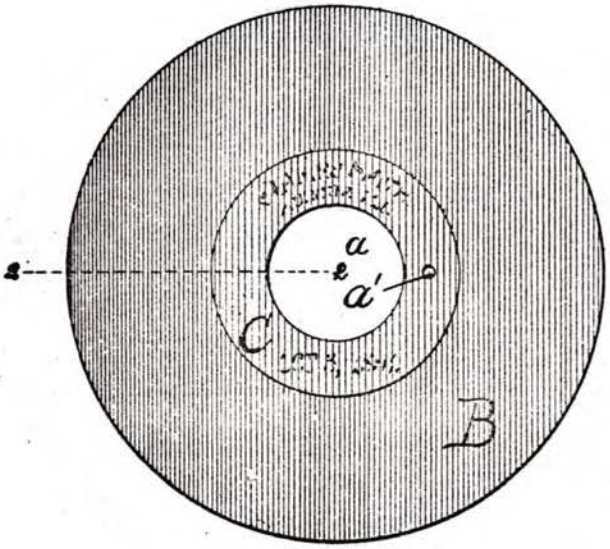
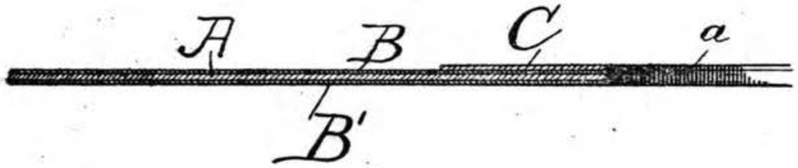


Fig. 2.



Witnesses:
Chas. E. Gaylord.
Irone Miller.

Inventor:
Joseph E. Wassenich
By Dayton, Poole & Brown
his Att'ys.

# UNITED STATES PATENT OFFICE.

JOSEPH E. WASSENICH, OF CHICAGO, ILLINOIS.

## TABLET FOR RECORDING SOUND-VIBRATIONS.

SPECIFICATION forming part of Letters Patent No. 505,910, dated October 3, 1893.

Application filed June 29, 1891. Serial No. 397,860. (Model.)

*To all whom it may concern:*

Be it known that I, JOSEPH E. WASSENICH, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Tablets for Recording Sound-Vibrations; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to the construction of tablets or disks for use in machines known upon the market as graphophones, or instruments for recording and reproducing vocal or other sounds, the tablet being the medium upon which the sound record is cut by the recording style. Such tablets have heretofore been constructed generally of a base or foundation of a rigid material provided with a surface coating of wax or a waxy composition. The tablets are sometimes cylindrical and sometimes flat. The base or foundation material has been composed of various materials, pasteboard, cardboard, leather, leatheroid, vulcanite and various other materials, but it is found that all these materials are liable to warp upon cooling of the wax or waxy composition when the latter is applied to the foundation or base, such application usually being made when the wax or waxy composition is hot. If, on the other hand, the base material is held rigid until the coating has been applied warping may occur at any subsequent time by reason simply of atmospheric changes to which the tablet may be subjected. In an attempt to overcome these difficulties and to prevent the formation of air bubbles in the wax by air held therein when cardboard or other porous material was used as a foundation, a metal base with a turned-up edge was proposed. When the hot waxy coating is applied to a thin metal base, the latter sometimes contracts unevenly and undulations are formed therein, thus preventing the tablet from being flat on the machine when receiving a sound record, and also affording the waxy coating a greater tendency to crack. Added to this objection was the additional weight of the metal over the cardboard or paper formerly used. When heavy cardboard, metal or a substantially rigid base has been employed, it is found that the slightest bending of the disk caused accidentally when the latter is transmitted through the mail, or otherwise, will crack the waxy surface and destroy the impression thereon, while on the other hand a coating upon one side of a cardboard or similar base would cause the latter to curl up. For these and other reasons a disk tablet has been heretofore found to be of no commercial or practical value and hence all sound recording and reproducing instruments are provided with cylinders or tubes having a waxy coating on their periphery. To remedy these difficulties and to produce a disk or tablet that shall be at the same time so flexible as to withstand the ordinary handling, and even bending, without cracking the surface or coating thereof and which even if it should be slightly bended, will, owing to its flexibility, be readily forced against the table at the point where the sound recording or receiving style is working and thus the tablet will be for all practical purposes substantially flat when in the machine; and also to produce a tablet that will be compact and durable as well as light in weight and capable of commercial application, are some of the objects of the present invention and the same consists in the matters hereinafter pointed out and set forth in the appended claims.

In the drawings, Figure 1 is a plan view of a disk illustrating my invention, and Fig. 2 is an enlarged vertical sectional view of a portion thereof, taken upon line 2—2 of Fig. 1.

In the drawings let A represent the base, preferably circular and provided with an opening or hole *a*.

*a'* is a hole or opening by which the disk may be suitably secured in position upon the machine by means of a suitable pin inserted therethrough.

B represents the upper and B' the lower coating upon the base A, and C represents a thin ring or disk of paper or the like, upon which latter the name of the person writing or receiving the letter or message placed upon the disk together with the date of the message may or may not be printed, written or stamped, at the convenience of the user.

In carrying out my invention, I use a thin flexible body such as paper or the like, ranging in thickness from about two one-thousandths to about five one-thousandths of an inch. To one or both surfaces of this base I apply a thin coating of ozokerite wax, say approximately about from two one-thousandths to about four one-thousandths of an inch in thickness. These figures are approximate only, the essential feature being a flexible wax on a flexible base to produce a flexible tablet. This coating may be very easily applied by machine or by hand by any of the well known processes for coating objects with wax. Cheapness is essential in order that tablets can compare favorably as a substitute for writing paper. Lightness in weight is required in order that a number of these tablets may be passed through the mails for the amount of the usual letter postage. Flexibility is required in order that the tablet may give and bend instead of cracking during ordinary handling and during its transmission through the mails. Compactness is desirable in order that in filing the tablets away a quantity of them may occupy the same or less space than an ordinary letter. In making the tablets as above described, about one hundred of them may be placed in a box one inch deep. Durability is required and very desirable in order that the tablets may stand a considerable amount of rough handling both in placing them upon and taking them off of the machine and otherwise handling the same.

A tablet made with a very thin base, as above described, and with an exceedingly thin coating on one or both sides, as above stated, will possess all of the desirable qualifications herein enumerated and avoid the objections heretofore pointed out as existing in the disks or tablets heretofore attempted.

As a separate and further improvement, I point out the utility of the disk C of paper or other material applied to the central portion of one or both sides of the tablet and upon which information may be printed or written whereby the particular disk and the message thereon may be recognized without placing the disk upon the graphophone or machine for that purpose.

As a further and separate improvement I make use of colored wax for the different disks whereby this identification may be the more complete. By the use of different colors in the different disks one writing machine may be used for several lines of business in the same office or for several persons in the same line of business without having the disks mixed or confused.

I do not desire to confine myself to the use of paper as a base nor to the use of an ozokerite wax as a coating inasmuch as any suitable base and any suitable coating which when united will produce an exceedingly flexible tablet will embody the essential feature of my invention.

Where I place a sound recording surface of wax or the like to one side only of the base or body of the disk, I find it convenient to paint or cover the other side of the disk with a very thin coating of varnish or other similar material having the same coefficient of expansion as the sound recording surface coating, this to prevent warping and cracking.

What I claim is—

1. A flexible disk for recording sound vibrations adapted for use on a flat tablet holder, composed of a disk of paper or other suitable flexible material, with a coating of a suitable flexible sound recording material thereon, substantially as described.

2. A flexible disk for recording sound vibrations, consisting of a thin flexible body of paper or other suitable flexible material, having on both sides a thin flexible coating surface of a suitable sound-recording material substantially as described.

3. A flexible disk for recording sound vibrations consisting of a thin flexible body of paper or other suitable flexible material having on both sides a thin coating of wax or a wax-like sound-recording material, substantially as specified.

4. A phonogram disk of such an attenuated thinness as to lie loosely on a flat tablet holder and adapt itself firmly against the face of same at point where record is being made, substantially as described.

5. A flexible phonogram disk for use on a flat tablet holder and adapted to receive a sound record in the form of a spiral groove, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

JOSEPH E. WASSENICH.

Witnesses:
TAYLOR E. BROWN,
GEORGE W. HIGGINS, Jr.

(No Model.) 4 Sheets—Sheet 1.

# H. J. LIORET.
## PHONOGRAPH.

No. 528,273. Patented Oct. 30, 1894.

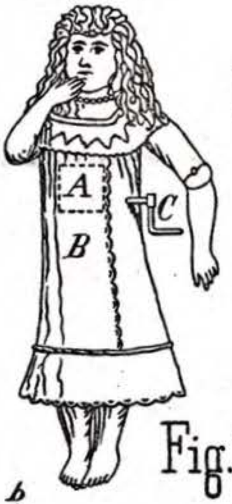


Fig. 9.

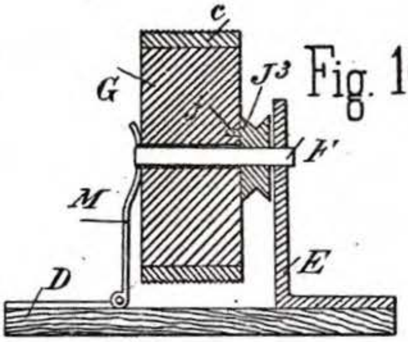


Fig. 10

Fig. 1

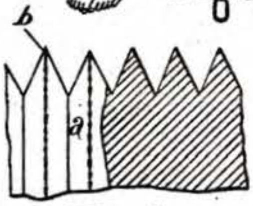


Fig. 2.

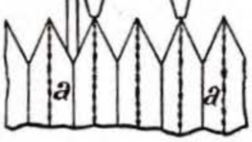


Fig. 3

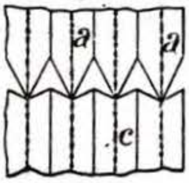


Fig. 4.

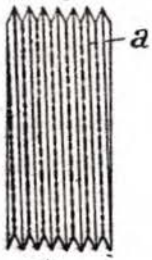


Fig. 5

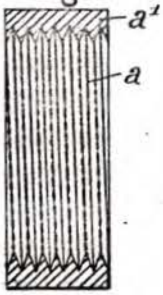


Fig. 6.

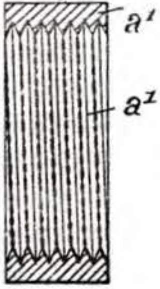


Fig. 7

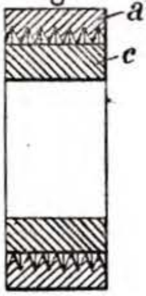
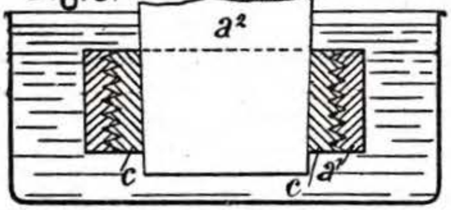


Fig. 8.



Witnesses:-
Fred Haynes
George Barry

Inventor:-
Henri Jules Lioret
by attorneys
Brown & Seward

(No Model.) 4 Sheets—Sheet 2.

H. J. LIORET.

PHONOGRAPH.

No. 528,273. Patented Oct. 30, 1894.

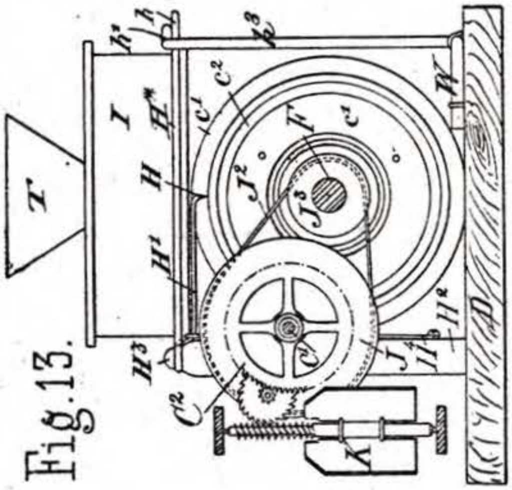


Fig. 13.

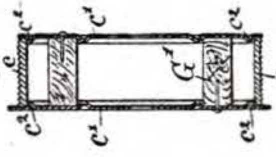


Fig. 11.

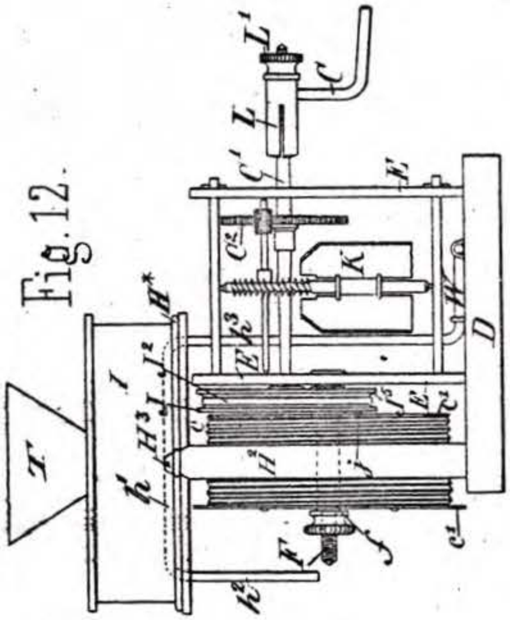


Fig. 12.

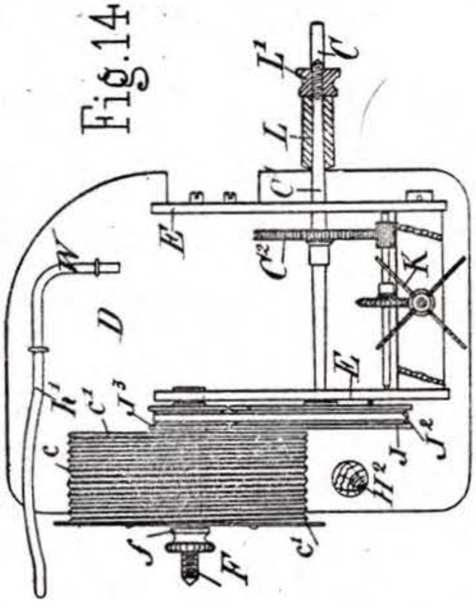


Fig. 14.

*Witnesses:-*

Fred Haynes

George Barry.

*Inventor:*

Henri Jules Lioret

by attorneys

Brown & Seward

(No Model.) 4 Sheets—Sheet 3.

H. J. LIORET.

PHONOGRAPH.

No. 528,273. Patented Oct. 30, 1894.

Fig. 15.

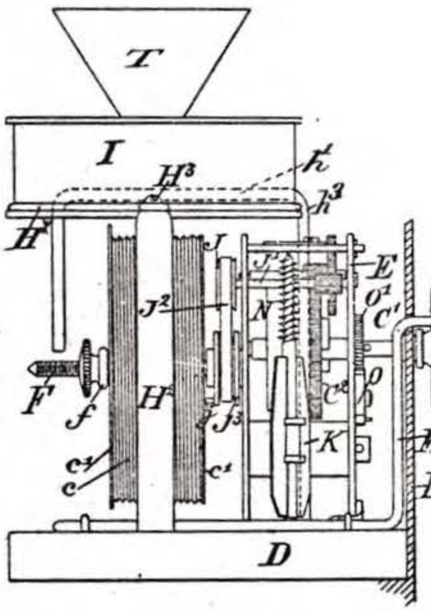


Fig. 16.

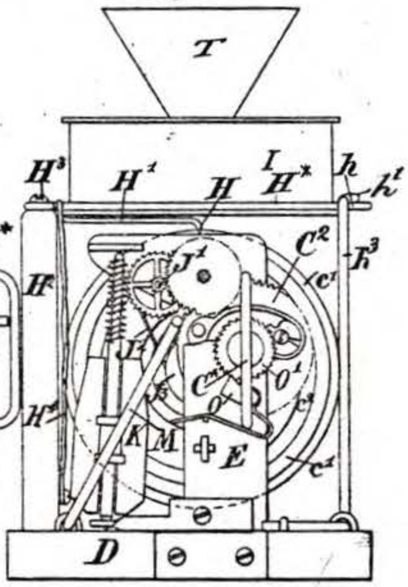
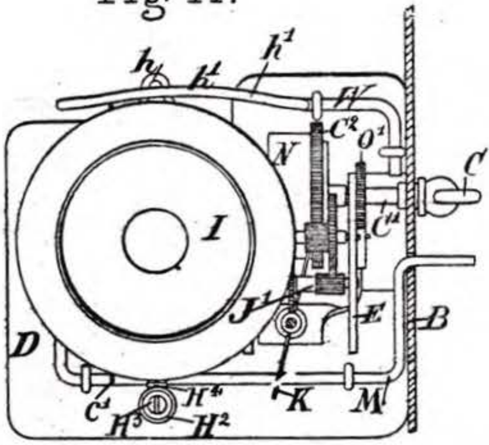


Fig. 17.



Witnesses:-
Fred Haynes
George Barry

Inventor:
Henri Jules Lioret
by attorneys
Brown & Seward

(No Model.)

4 Sheets—Sheet 4.

H. J. LIORET.

PHONOGRAPH.

No. 528,273.

Patented Oct. 30, 1894.

Fig. 18.

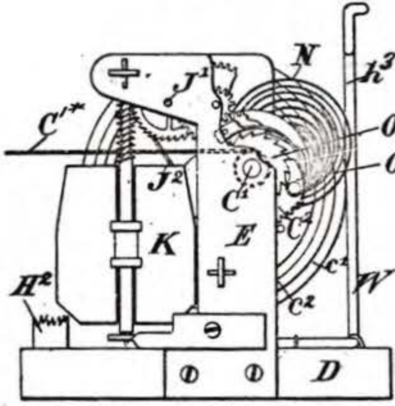


Fig. 19.

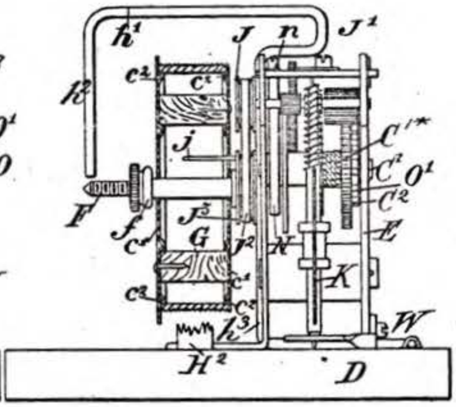
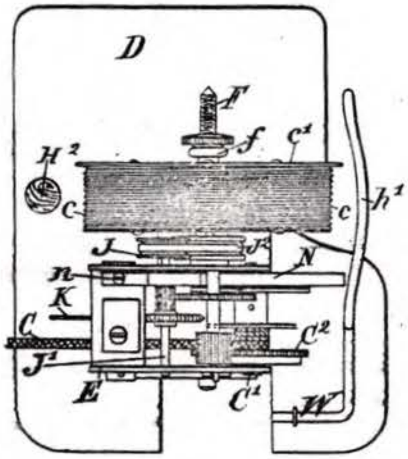


Fig. 20.



Witnesses:-

Fred Haynes

George Barry.

Inventor:-

Henri Jules Lioret

by attorneys

Brown & Seward

# UNITED STATES PATENT OFFICE.

HENRI JULES LIORET, OF PARIS, FRANCE.

## PHONOGRAPH.

SPECIFICATION forming part of Letters Patent No. 528,273, dated October 30, 1894.

Application filed December 20, 1893. Serial No. 494,179. (No model.) Patented in France May 18, 1893, No. 230,177.

*To all whom it may concern:*

Be it known that I, HENRI JULES LIORET, of Paris, in the Republic of France, have invented a new and useful Improvement in Phonographs, (for which I have obtained a brevet d'invention of the Republic of France, No. 230,177, dated May 18, 1893,) of which the following is a specification.

The object of my invention is to construct phonographs at a low price and consequently to provide for their application to very numerous purposes, such for instance, as the manufacture of new toys.

My invention relates in the first place to the construction of the cylinder or roller intended to receive the impressions of the recording style which is carried by the vibrating plate, diaphragm or membrane which is spoken against, whereby the said cylinder, when engraved or impressed, may be used as a matrix to reproduce a great number of times the same impressions upon other cylinders which I call reproduction cylinders.

The improvement also relates to the mode of mounting or setting up these reproduction cylinders; also to the arrangement of the receiving style and of the resonant box or resonator to which the said style is adapted; and further to the motor mechanism of the phonographic apparatus.

In the accompanying drawings Figure 1 is a profile view of part of a matrix cylinder. Fig. 2 is a similar view showing the mode of guiding the style upon the fillets of the matrix cylinder. Fig. 3 is a similar view of part of the matrix cylinder and of the reproduction cylinder which may be obtained from it. Figs. 4 to 8 represent successive stages of the manufacture of a reproduction cylinder of celluloid and will be hereinafter more particularly described. Fig. 9 represents a doll furnished with my apparatus. Fig. 10 is a sectional view representing one way of mounting the cylinders of my system. Fig. 11 is a similar view showing another mode of mounting my cylinders. Figs. 12 and 13 represent elevations at right angles to each other, Fig. 13 being partly in section, of one example of a complete apparatus embodying my invention. Fig. 14 is a plan view partly in section, corresponding with Figs. 12 and 13. Figs. 15 and 16 represent elevations at right angles to each other, Fig. 16 being partly in section, of a second example. Fig. 17 is a plan view corresponding with Figs. 15 and 16. Figs. 18 and 19 represent elevations at right angles to each other, Fig. 19 being partly in section, of a third example. Fig. 20 is a plan view corresponding with Figs. 18 and 19.

Similar letters of reference designate corresponding parts in all the figures.

The matrix cylinders are obtained in the following manner: I take a sleeve or hollow cylinder of soft steel having on its outer circumference a thread with triangular cross-section of suitable fineness and place it in front of the recording style attached to the vibrating plate or diaphragm which is spoken against, so arranging the said sleeve and style that the point of the style engraves its impressions successively along the top angle of the thread; this being where the resistance to penetrate is the least, first because of the slight thickness of metal presented and second, by reason of the absence of lateral contact or friction due to contiguous surfaces because such surfaces do not exist in the neighborhood of the top angle of the thread; where the style may act with more efficacy and cut in a suitable manner in the sharp edge the impressions which are to be left upon the cylinder.

To receive the impression of the sonorous vibrations the threaded sleeve or cylinder is keyed upon an arbor which is terminated by a screw of the same pitch engaged in a nut. In front of the cylinder or sleeve thus mounted I arrange any appropriate phonographic recording apparatus—for example a vibrating membrane furnished with a style, taking care that the style bears upon the angle of the thread of the cylinder. If then the arbor is set in motion, the cylinder turns in front of the style and if one speaks against the membrane the style will engrave along the angle of the thread impressions of form and depth corresponding with the nature of the sonorous vibration. The cylinder being thus engraved I temper it and thus obtain a cylinder which may be employed to produce the vibration of the membrane of the receiver and reproduce sounds which have been made in front of it.

The first part of my invention is indicated in Fig. 1 which represents an elevation and section of portions of the threaded cylinder showing the impressions $b$ cut in the angle of its thread by the recording style.

When the matrix cylinder $a$ is employed directly to make the receiver speak, the receiving style $d$, of which the blunt point should rest upon the angle of the thread as shown toward the left of Fig. 2, bears upon an additional lateral point $d'$, which is engaged in the groove of the thread in such manner as to be guided by it and to produce naturally the advance both of itself and of the receiving style without which there would be necessary for the latter a screw or other mechanism of some kind or other corresponding with the thread of the cylinder. There might also be employed a style with a point broadened and hollow in the form of a crescent in such manner as to embrace the angle of the thread and yet only rest upon it by a point as shown toward the right hand of Fig. 2. It has been mentioned how the cylinder engraved upon the angles of its thread and then tempered may be employed directly to produce the speech of the receiver; its great hardness assuring it the advantage, quite new, of great durability; but it may also, as I have said, serve as a matrix or as a rowel utilizable to produce directly a great number of times and consequently in a very economical way upon other cylinders of soft metal or other suitable material, impressions which will enable them to be used to put in vibration the membrane of the receiver. These are the new cylinders which I have designated under the name of reproduction cylinders.

When it is desired to obtain a cylinder of soft metal or other analogous material it may be done directly by simply causing the matrix to roll under a suitable pressure upon a cylinder of the same diameter in such manner as shown in Fig. 3, or else upon a ribbon of suitable profile which may be afterward enrolled upon a roller. The reproduction cylinder has preferably a thread of the same pitch as that of the matrix cylinder in order that the impressions engraved upon the angle or top of the thread of the latter may be reproduced in the bottom of the thread of the reproduction cylinder as shown in Fig. 3. The ribbon may also present striations or grooves which, when it is enrolled upon its roller, will constitute a threading. In this case the impressions are also reproduced at the bottom of these striations or grooves. In fact these impressions will be counterparts of those of the matrix cylinder, but that is without importance from the point of view of the reproduction of the sounds.

It is hardly necessary to remark that when use is made in the receiver of the reproduction cylinder $c$ like that which has just been described, the receiver style may be guided very simply by making its point bear on the bottom of the cavity of the thread.

It may be remarked (see Fig. 3) that the threading of the reproduction cylinder $c$ is not so deep as that of the matrix cylinder $a$ in order to facilitate the reproduction. This threading only needs to be deep enough for the guidance of the style.

When the reproduction cylinders are not required to be so durable, instead of making them of soft metal or other analogous matter, they may be made of celluloid. This material presents the advantage of well preserving the impressions, not being liable to break and above all not being sensibly influenced by atmospheric variations. Moreover, besides being homogeneous and very hard, they cut and mold sharply and they wear well.

To produce the cylinders of celluloid, I operate as follows: I prepare the matrix cylinder $a$ (Fig. 4) as I have hereinbefore described. Then I take upon it as is shown in Fig. 5, a galvano-plastic mold $a'$ which presents consequently the form of a tube having in its internal surface the counterpart of the threading and the impressions of the matrix cylinder $a$. (See Fig. 6.) I remove this tube from the matrix cylinder by first heating it externally to expand it sufficiently to enable it to be unscrewed from the said cylinder, the impression being so slight that very little expansion is necessary. After its removal I introduce into the said tube a sleeve or ring $c$ of celluloid (see Fig. 7) just large enough to enter it freely, then plunge the whole into hot water. The celluloid is thus softened, and I then introduce forcibly into the said collar or ring $c$ a mandrel $a^2$ sufficiently large to dilate the said ring or collar and cause it to penetrate into all the cavities of the mold $a'$ as shown in Fig. 8. I then plunge the whole into cold water and the celluloid recovers its hardness and is at the same time generally contracted sufficiently to permit the easy withdrawal of the ring $c$ from the mold $a'$ by unscrewing it therefrom. If, however, the contraction of the ring $c$ in this way is not sufficiently greater than that of the mold $a'$, the mold may be slightly warmed by heat externally applied.

It may be here mentioned that the impression produced by the style on the matrix cylinder and reproduced in reverse in the mold $a'$ is so slight that only a very slight dilation of the ring $c$ is necessary to obtain the impression on it and a very slight contraction to permit it to be unscrewed from the mold $a'$ without damaging said impression.

It may be further mentioned that the threads of the matrix are very fine in practice and are very much exaggerated in the drawings to facilitate the illustration. This ring $c$ thus becomes finally a reproduction cylinder which is an exact reconstitution of the matrix cylinder $a$. This method is rapid and economical and gives perfect results. It may be understood moreover that according as the impressions have been engraved upon the angle or in the bottom of

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the thread of the matrix $a$, the cylinder $c$ will also have the impressions upon the angle or in the bottom of its thread and that the receiver style should be formed to correspond.

In the following description of examples of my invention I will suppose the phonograph arranged in the body of a doll as shown in Fig. 9, but it will be understood that it is capable of any other application.

For whatever purpose they are to be applied the cylinders $c$ obtained by either of the means which I have just described may be fastened upon a cylindrical drum G, made of wood for example, which is fitted to turn freely upon a fixed arbor F. This arbor is carried by a standard E fixed upon a base D as shown in Fig. 10. It also receives a loose pulley $J^3$ carrying a pin $j$ which enters into a hole in the drum G in such manner as to drive the cylinder $c$. A hinged spring arm M serves to hold the drum G and cylinder $c$ in place upon the arbor but permits their removal therefrom. When the cylinder $c$ is of celluloid I prefer to mount it in another way as is shown in Fig. 11, that is to say, to place it between two thin disks $c'$ forming jaws and having annular centering projections $c^2$ on their inner faces. These two disks are maintained at a suitable distance apart by a wooden ring G′ to which they are nailed. The cylinder $c$ thus mounted is placed upon the arbor F, the disks $c'$ having central holes which fit the said arbor.

As to the mechanism for driving the cylinder $c$, it may be varied in many ways, but it is characterized in all cases by the fact that the motive power is not applied directly to the arbor F of the said cylinder $c$, but to a driving spindle C′ (see Figs. 12 to 20) between which and the said cylinder there is an elastic or yielding power-transmitting device. In the example represented this power-transmitting device consists of an india rubber driving belt $J^2$ running on a driving pulley J on the spindle C′ and on the pulley $J^3$ hereinbefore mentioned. The principal advantage of this method of driving is that the elastic belt may allow the driving pulley J to slip a certain distance without letting it go altogether when the cylinder $c$, which has a considerable relative weight, acts as a flywheel to remedy any inevitable inequalities in the speed of the driving spindle C′, especially if it is moved by hand.

In my apparatus the blunt pointed receiver style H is affixed to or formed by the extremity of a horizontal arm H′ which carries a cylindrical resonance box or resonator I of any suitable material, the style being rigidly fixed under the center of this resonator. The said arm H′ is mounted freely upon a pivot $H^3$ carried by a column $H^2$ in such manner that while free to turn on this pivot the ensemble formed by the resonator and the style rests freely upon the cylinder by its own weight and may follow a generatrix of the cylinder in the threading of which the style is always guided as has been previously described. For greater simplicity, the style, the arm which carries it, and the support for the box may be constituted as shown in the drawings, by one and the same metal wire, preferably of steel, which surrounds the base of the resonator, as shown at $H^*$, forms an eye around the pivot $H^3$ and passes under the base of the resonator to form the arm H′ the extremity of which is bent down and pointed in such manner as to constitute the style H.

As to the column $H^2$, it is simply placed tightly in a hole in the base D. In order to insure a better contact between the style and the cylinder, the metal wire which carries the resonator and which forms the style is constantly pulled downward by a spring of any suitable kind as an elastic band $H^4$, of which one of the ends is attached to a fixed point. Moreover, the metal wire has formed in it a loop $h$ which projects from the resonator and constitutes a guiding arm and which, being guided under a suitably arranged guide $h'$, prevents the resonator I and the style H from being accidentally separated from the cylinder beyond a certain distance, when the apparatus receives a shock for example. The said guide $h'$ is represented as formed by the horizontal upper portion of a fixed yoke W made of strong wire and fastened to the base D, which yoke has also two vertical branches $h^2$ and $h^3$. When the resonator in turning about the pivot $H^3$ arrives at the end of its course in one direction or the other, that is to say, when the style has run the entire length of the cylinder, its guiding arm $h$ encounters one of the vertical branches $h^2$ $h^3$ of the yoke and prevents the resonator and the style from running any farther. On the other hand, when the apparatus is reversed, the guiding arm $h$ coming against the guide $h'$ prevents the resonator from being too far separated from the cylinder. Were it not for this guide all the weight of the resonator would be thrown back upon the loop which forms the eye around the pivot $H^3$ at the bending of said loop, thereby disarranging the said apparatus.

The resonator has preferably an opening in its top to receive the end of a trumpet T which facilitates the proper propagation of the sound.

When the cylinder is turned in the proper direction to make the apparatus speak, the style follows freely the thread of the cylinder $c$ and when it has arrived at the extremity of the cylinder all that has to be done is to shift it to the other end to make the apparatus repeat its speech.

The phonographic apparatus thus set up may be driven by hand or else by the aid of a clock mechanism. In the apparatus represented in Figs. 12 to 14, the movement is produced by the turning of a hand-crank C. This crank, instead of being keyed upon the spindle C′, is carried by a split socket L mounted upon a slightly conical portion of the spindle $C'$ A nut $L'$ screwed on to the end of the said spindle serves to regulate the tightness and the adhesion between the socket and the spindle.

The spindle $C'$ has geared with it and drives a fly regulator K. The resistance presented by the air to the movement of this fly increases with the speed of the latter, but there is one speed of rotation of the crank C and spindle $C'$ at which this resistance is equal to the adhesive force of the socket L on the spindle $C'$. If this limitation of speed is passed the resistance opposed to the driving mechanism by the fly K becomes superior to the force of adhesion of the socket L and the latter slides upon the spindle $C'$ which preserves always a constant speed limited to the desired degree.

In the example represented in Figs. 15 to 17 the drum G and cylinder $c$ are driven by a spring clock mechanism which is wound by means of a key $C^*$. In this example the fly regulator K is applied as in the example previously described.

I employ very simple means of starting and stopping the clock movement. This means consists of a movable stop M mounted upon the base D in such manner as to be capable of sliding forward and backward when manipulated by means of a prolongation $m$ suitably guided. When, after the winding, this stop M has been brought to the position indicated in the drawings, the clock movement is permitted to operate because the fly K is allowed to turn freely without encountering the said stop; but on the other hand, the winding is impossible because the key in turning would be arrested by the prolongation $m$ of the stop. If on the contrary, the latter is pushed inward the winding becomes possible but the movement is stopped because the fly in turning would encounter the stop and be thereby stopped.

In the example represented in Figs. 18 to 20 the mechanism is simplified by substituting for the clock movement a simple spring N of which one of the extremities is attached to the fixed pin $n$ and the other is attached to the motor spindle $C'$. To produce the winding, all that it is necessary to do is to draw a small cord $C'^*$ which is enrolled upon a drum keyed upon the spindle $C'$. The spindle is thus made to turn in the desired direction to wind the spring N. During this movement the transmitting mechanism does not turn because the gear $C^2$ is loose upon the spindle $C'$ and the pawl O which is carried by the said gear may slip over the teeth of the ratchet wheel $O'$ keyed upon the said spindle; but when the cord $C'^*$ is let go, the spring tends to produce the turning of the spindle $C'$ in a reverse direction. The ratchet wheel $O'$ then drives the gear $C^2$ and consequently sets in movement all the transmitting mechanism. The speed of this movement is also regulated by the fly K.

I have supposed in the example represented as I have hereinabove stated, that the phonographic apparatus was placed in the cavity A provided in the body B of a doll (Fig. 10). It is then arranged in such manner that one may from the exterior operate the crank C or wind the clock movement by means of the key $C^*$ or the cord $C'^*$

One or more of the walls of the cavity A should be very thin and also pierced with holes in order that there may be no obstacle to the propagation of the sound.

What I claim as my invention is—

1. In a phonograph, the combination with a spirally threaded cylinder, a style $d$ having a point which runs on the top of the thread of the said cylinder and an additional guiding point $d'$ engaging in the groove of said thread, substantially in the manner and for the purpose herein described.

2. In a phonograph, the combination with a threaded cylinder and a resonator turning about a fixed pivot and furnished with a style to follow the threading of the cylinder, of a guiding yoke comprising a horizontal portion and vertical branches, and a guiding arm carried by the resonator and engaging under the horizontal portion of said yoke, substantially as and for the purpose herein described.

3. The method of reproducing phonographic cylinders which consists in first obtaining a metal mold by electro-deposit upon an original phonographic cylinder, next placing bodily within the so obtained mold a solid ring of plastic material capable of being softened by heat, next softening this ring by heat, and finally so distending the said ring within said mold by internal pressure that it will receive therefrom an impression corresponding with that of the original cylinder, substantially as herein described.

4. The combination in a phonographic cylinder, of a hollow cylinder $c$, disks $c'$ having centering projections for said hollow cylinder and a spacing ring $G'$ arranged between said disks and means of securing said disks to said spacing ring, substantially as herein described.

5. The combination with a motor for operating a phonograph, of a driving crank on the main spindle of said motor, an adjustable friction device between said crank and spindle and a rotary fly geared with and driven by said motor, substantially as and for the purpose herein set forth.

In witness whereof I have hereunto set my hand in the presence of two subscribing witnesses.

HENRI JULES LIORET.

Witnesses:

MAURICE MERCIER,
CLYDE SHROPSHIRE.

(No Model.)

# E. BERLINER.

## SOUND RECORD AND METHOD OF MAKING SAME.

No. 548,623. Patented Oct. 29, 1895.

Fig. 1.

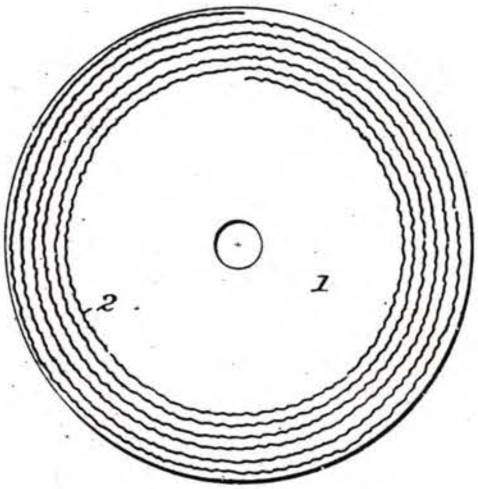
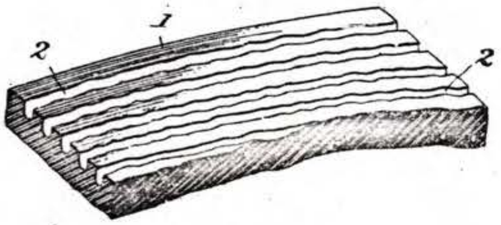


Fig. 2.



Witnesses
Jno. G. Hinkel,
F. T. Chapman

Inventor,
Emile Berliner,
By Joseph Lyons.
Attorney

# UNITED STATES PATENT OFFICE.

EMILE BERLINER, OF WASHINGTON, DISTRICT OF COLUMBIA

## SOUND-RECORD AND METHOD OF MAKING SAME.

SPECIFICATION forming part of Letters Patent No. 548,623, dated October 29, 1895.

Application filed March 18, 1893. Serial No. 466,708. (No model.)

*To all whom it may concern:*

Be it known that I, EMILE BERLINER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Processes of Making Copies of Sound-Records; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in sound-records and in the method of making the same.

The present invention relates more particularly to the production of copies or duplicates of the flat sound-records as made by gramophone in the manner set forth in Letters Patent granted to me on November 8, 1887, No. 372,786, and on May 15, 1888, No. 382,790.

The sound-records, as is well-known, consists of undulatory grooves of even depth, as distinguished from non-undulatory grooves of varying depth produced by other methods of recording sounds.

The sound-records of the gramophone are generally zinc disks into which a spiral record of sound-waves is etched. Other substances than zinc capable of being etched into may of course be used.

The simplest way for making a duplicate copy of such a record is to impress it in wax, deposit copper thereon, and detach the copper shell. This is the well-known method used by electrotypers. There is, however, a loss in the perfection of the surface, resulting from the fact that electrotypers' wax is porous and uneven of surface, and the resultant copper copy containing the sound-record is not as good in tone quality as the original. It is therefore necessary to deposit a copper or other metallic matrix directly on the original zinc record. This I do by first thinly covering the zinc with a material capable of resisting the action of the sulphate of copper solution usually employed for electro plating or typing, and then deposit copper over that, and when thick enough detach the copper deposit.

My method is to cast the previously-cleaned zinc-record disk in a cyanide-of-copper or cyanide-of-brass solution, electrolytically, by which a very thin film of copper or brass adheres to the zinc. After being thus prepared, the coated zinc disk is placed into a sulphate-of-copper bath and copper deposited on it electrolytically. The deposit when thick enough is then detached and forms an accurate matrix, showing the sound-record of the zinc disk in reverse. This matrix can then be impressed into suitable material and thereby produce exact duplicates of the original record-sheet.

I have found hard rubber and celluloid to be excellent materials from which to make such duplicates. These substances when heated become very soft, and when in this soft state they are impressed with a matrix, such as above described, and are cooled while still under pressure, and the resultant rubber or celluloid sheet retains all the characters of the matrix, and thus forms a copy record of the original zinc disk. In impressing a copper matrix on softened rubber, however, the sulphur fumes which are generated when heating the rubber attack the copper and destroy the smoothness of its surface. I have therefore found it necessary to coat the copper matrix with a substance capable of withstanding the sulphur fumes, and I find electrolytically-deposited iron or nickel a proper substance to accomplish the desired effect. The copper matrix is therefore cleaned and placed in a nickel or iron bath, and a thin coating of iron or nickel is deposited on it by an electric current. The matrix thereby becomes protected against sulphur fumes, and iron and nickel being harder than copper the matrix, by being thus coated, becomes more durable, and withstands pressure for a longer period. It is also possible with such a matrix to press unvulcanized rubber into it, vulcanize the rubber while attached to the matrix, and then detach it, when a true copy of the original sound-disk will be the result.

In the annexed drawings, forming part of this specification, there is shown in Figure 1 a plan view of a sound-record made in accordance with the present invention, with the lines representing the record greatly exaggerated; and Fig. 2 is a perspective view of a small portion of a sound-record copy on an enlarged scale.

Referring to the drawings, there is shown a

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disk 1, of hard rubber or like material, having in its face an undulatory spiral groove 2 of even depth representing sound-waves.

What I claim is—

1. The process of duplicating flat sound records, which consists in depositing copper or other like metal on an original record, then detaching the copper reverse thus produced and facing the same with a layer of hard metal which is not attacked by sulphur, and then pressing the reverse into temporarily softened hard rubber, substantially as described.

2. The process of duplicating flat sound records, which consists in facing an electro-deposited reverse of a record, with nickel or iron, and then pressing this reverse into hard rubber, substantially as described.

3. As an article of manufacture, a sheet of hard rubber having upon its face an undulatory groove of even depth representing sound waves, substantially as described.

4. As an article of manufacture, a sheet of hard rubber having pressed into its face an undulatory line of even depth representing sound waves, substantially as described.

5. A copy of a flat sound record, which consists of a disk of hard rubber having impressed upon its face the lines representing the record, substantially as described.

In testimony whereof I have affixed my signature in presence of two witnesses.

EMILE BERLINER.

Witnesses.  
S. E. YOUNG,  
GEORGE SEIDENSPIMER.

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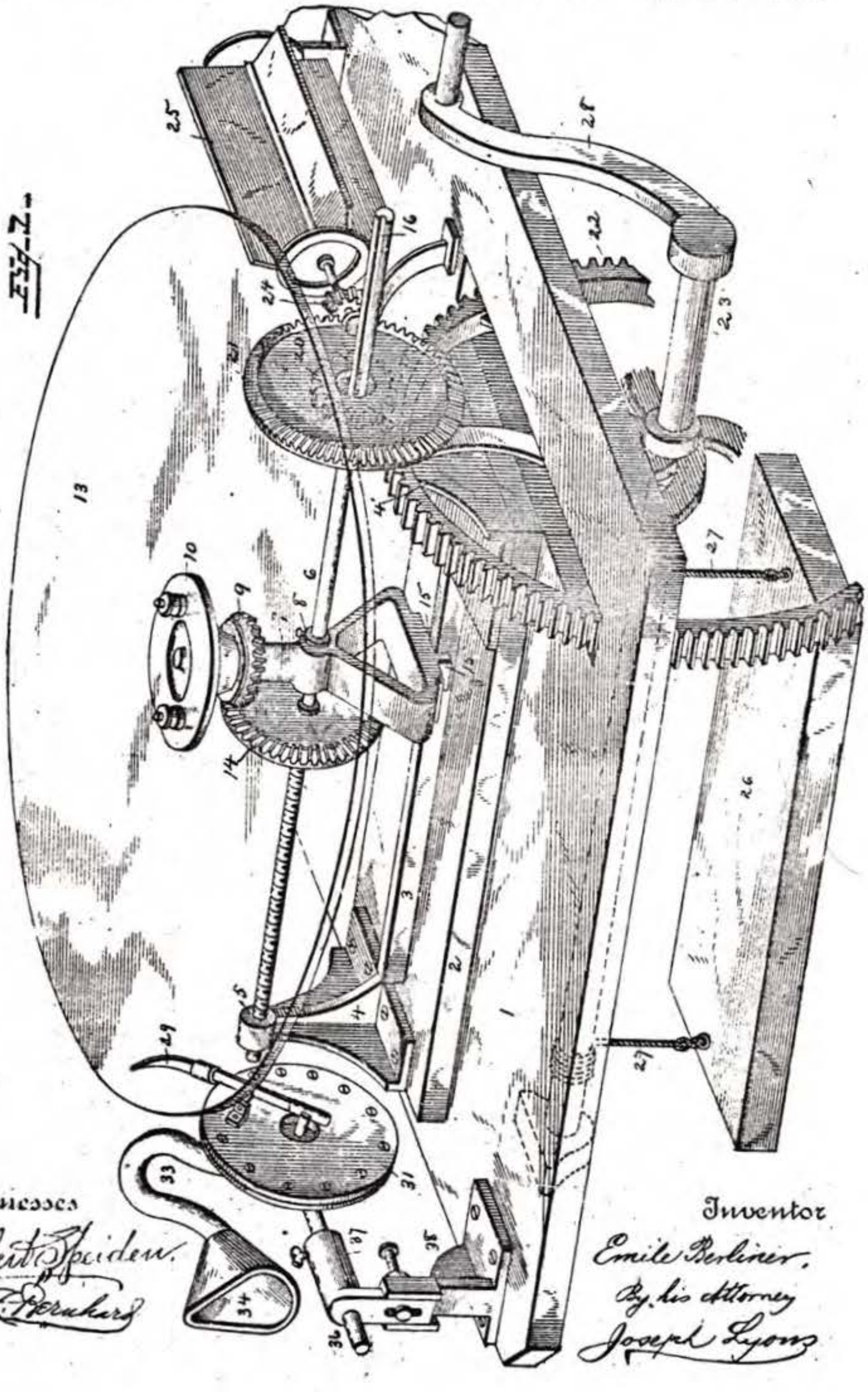
(No Model.) 3 Sheets—Sheet 1.

# E. BERLINER.

## GRAMOPHONE.

No. 564,586. Patented July 28, 1896.

Fig. 2.



Witnesses
Albert Speiden.

Inventor
Emile Berliner.
By his Attorney
Joseph Lyons

(No Model.) 3 Sheets—Sheet 2.

E. BERLINER.
GRAMOPHONE.

No. 564,586. Patented July 28, 1896.

Fig. 2.

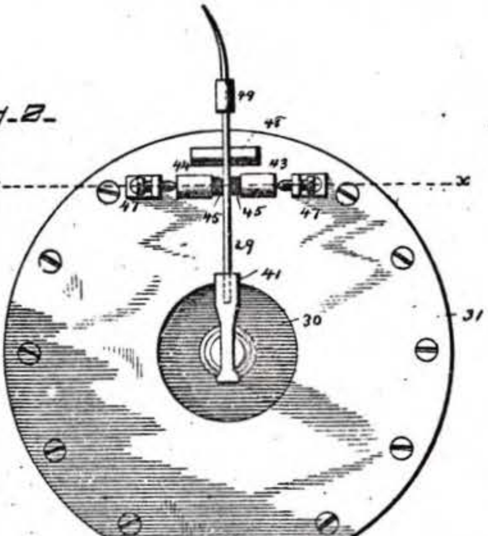


Fig. 6.

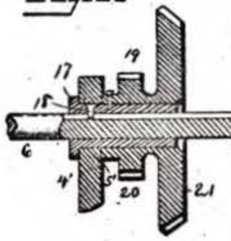


Fig. 7.

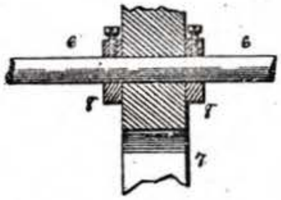


Fig. 4.

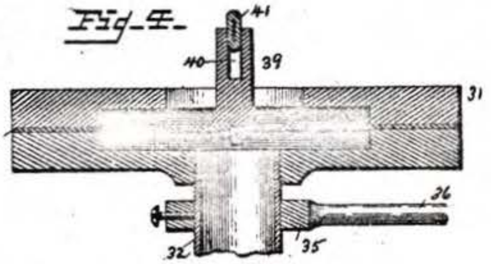
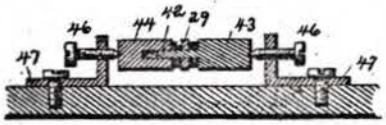


Fig. 5.



Witnesses
Albert Spieden.
F. Bernhard

Inventor
Emile Berliner.
By his Attorney
Joseph Lyons.

(No Model.) 3 Sheets—Sheet 3.

E. BERLINER.

GRAMOPHONE.

No. 564,586. Patented July 28, 1896.

Fig. 9.

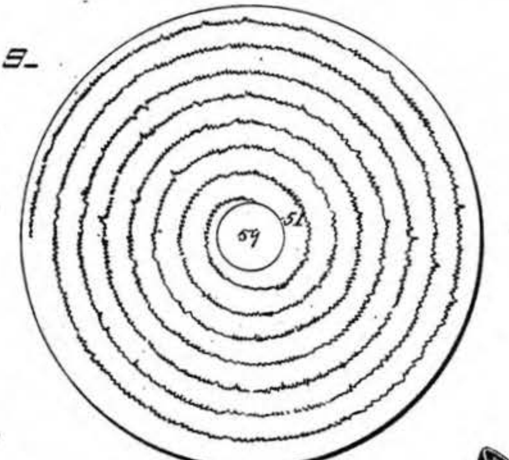


Fig. 8.

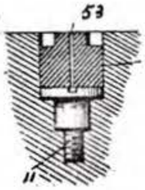


Fig. 10.

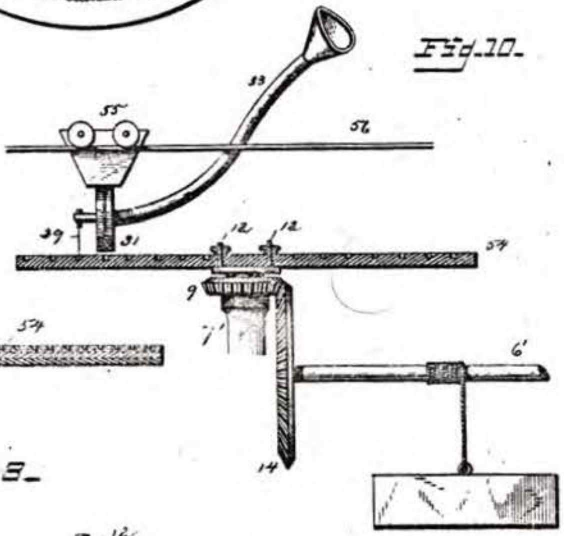


Fig. 11.

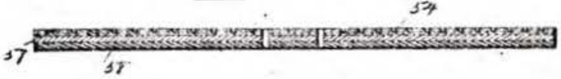
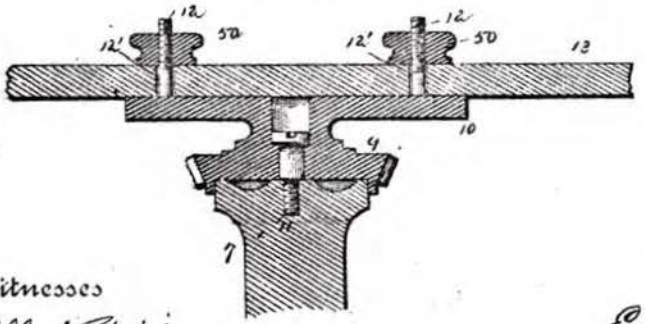


Fig. 9.



Witnesses

Albert Speiden.

H. F. Burckhard

Inventor

Emile Berliner,

By his Attorney

Joseph Lyons

# UNITED STATES PATENT OFFICE.

EMILE BERLINER, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE UNITED STATES GRAMOPHONE COMPANY, OF WEST VIRGINIA.

## GRAMOPHONE.

**SPECIFICATION** forming part of Letters Patent No. 564,586, dated July 28, 1896.

Application filed November 7, 1887. Serial No. 254,541. (No model.) Patented in England November 8, 1887, No. 15,232.

*To all whom it may concern:*

Be it known that I, EMILE BERLINER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Gramophones, of which the following is a specification.

My invention has reference to improvements in methods of and apparatus for recording and reproducing spoken words and other sounds, and it is primarily intended as and constitutes an extension and improvement of my gramophone which I have described in Letters Patent No. 372,786, granted to me on November 8, 1887, and for which I have also received Letters Patent of Great Britain, No. 15,232, dated November 8, 1887. In said patents I have described a method of recording and reproducing sounds, which consists in first causing the sounds to inscribe themselves upon a layer of non-resisting material in a manner substantially like that practiced by the well-known Leon Scott phonautograph, then copying the phonautographic record in solid resisting material, preferably by the photo-engraving process, and then reproducing the sounds from the solid copy of the record. The original record, as well as the copy of the same, is thus obtained as an undulatory line of even depth, as distinguished from a line of varying depth obtained by the ordinary phonograph and by the graphophone.

In my present invention I retain all the fundamental features of my gramophone, but introduce certain novel features both in the process and in the apparatus, which render the attainment of the objects of a sound recorder and reproducer more certain and more perfect.

In the original form of my gramophone I employed a curved (cylindrical) surface upon which the non-resisting medium used for recording was supported. This had the disadvantage that for the purpose of copying the record by the photo-engraving process such surface had to be first straightened and the flat copy obtained from the same had to be bent again to the original cylindrical form of the record-surface. This involved delicate and tedious manipulations, which I avoid in my present invention by inscribing the record of sounds upon a flat plate, and I further improve the process by arranging that flat plate horizontally, or nearly so, and by inscribing the record upon the under surface of the same, whereby the material removed by the recording-stylus drops away from the plate and leaves the undulatory groove of even depth, clean, and well defined, whereas by the old method the material removed by the stylus accumulated in and about the adjacent grooves.

I have further improved the process by using a transparent plate as a support for the non-resisting medium. This plate is therefore made either of glass or some other like substance, whereby I secure several important advantages. The most important of these advantages is that it enables me to work with parallel transmitted rays of light in the subsequent process of photo-engraving, in which the original record is thus used as a negative, which may be directly applied in contact with the sensitive photographic plate, and another important advantage is the reduction of the friction of the stylus upon the supports to a minimum.

The process is further improved by the employment of a new recording medium. In the original process I used a layer of lampblack pure and simple, and this substance is well adapted for the purpose on account of the slight coherence of the particles; but by reason of the flocculent nature of this substance the lines drawn upon it are more or less ragged, as can be observed under a microscope, and the photo-engraving obtained from such record displays all the defects of the original. In my improved process I employ a layer of a semifluid ink or paint, of such consistency and thickness that it will neither subside nor flow spontaneously. Such ink is practically structureless, and the lines drawn upon it are exceedingly sharp and reveal no ragged edges under a powerful microscope, and the photo-engraving from such record is far superior to a like copy from a record produced under the former process.

My invention also comprises other minor improvements in the process, and it also covers novel features in the apparatus, all of which will more fully appear from the following detailed description, in which reference is made to the accompanying drawings, in which I have illustrated convenient forms of apparatus which I have used, without, however, limiting myself to the exact details of the same.

Figure 1 is a perspective view of my improved gramophone. Fig. 2 is a plan view of the diaphragm, with its support and accessories. Fig. 3 is a vertical section showing the recording-disk and its connection with the driving-wheel. Fig. 4 is a sectional view of the diaphragm, its support, and accessories. Fig. 5 is a cross-section on line *x x* of Fig. 2. Fig. 6 is a sectional view of a part of the driving-gear. Fig. 7 is a section showing the connection of the driven shaft with the support of the recording-disk. Fig. 8 is a sectional view of a centering device. Fig. 9 is a plan view, upon a reduced scale, of a disk with a record of sounds recorded upon the same in accordance with my invention. Fig 10 is a sectional elevation of a modified form of my reproducing apparatus, and Fig. 11 is a sectional view of a dampened reproducing-disk.

Referring now to the drawings, in which the details are marked by numerals, there is a platform 1, suitably supported, and upon this platform are mounted the operative parts of the apparatus. A metallic plate 2, provided with a longitudinal rib 3, is secured upon the platform, and standards 4 4', mounted upon plate 2, are provided with a nut-bearing 5 and a smooth bearing 5', (see Fig. 6,) respectively, for shaft 6, which extends through these bearings, as shown. One-half, more or less, of this shaft is screw-threaded, as shown, and enters the nut-bearing 5, and at a point near the middle said shaft passes loosely through a movable support 7, the position of which upon the shaft is determined by two collars 8 8, as indicated in Fig. 7.

The support 7 serves as a bearing for a bevel-gear 9, which is centrally perforated and widens out into a circular flange 10. Upon its under side the bevel-gear 9 is recessed, and said recess fits loosely over the upper end of support 7. A screw 11, passing loosely through the central perforation of bevel-gear 9, screws into the head of support 7, so that the bevel-gear can rotate about its axis, which coincides with the axis of screw 11. Two screw-pins 12 12, which may be either fixed or removable, project at diametrically opposite points from flange 10, and are designed to pass through two similarly-located holes in a glass plate 13, as will be more fully described hereinafter.

A bevel-gear 14, fixed upon shaft 6, engages bevel-gear 9, but provision is made for releasing gear 14 from the shaft, if desired, for a purpose which will be explained farther on. As stated above, the screw-threaded portion of shaft 6 passes through nut-bearing 5, and it will now be clear that if shaft 6 is rotated bevel-gear 9, with its flange 10, will likewise rotate, and will at the same time advance in a straight line, since shaft 6, screwing into or out of its nut-bearing 5, will carry bevel-gear 14 and support 7 with it. From the bottom of support 7 two lugs 15 15, one on each side of rib 3 of plate 2, serve to guide the support with the parts attached thereto in the line of said rib, which is, of course, parallel to shaft 6.

A part of the smooth portion of shaft 6 has a longitudinal groove 16 extending to the right-hand end of the shaft, as seen in Figs. 1 and 6, and a sleeve 17 loosely fitting this portion of the shaft has a pin 18, the end of which engages groove 16, as shown in Fig. 6, so that the shaft is free to slide longitudinally through sleeve 17 and will rotate with the same if the latter is rotated.

Sleeve 17 is fitted into bearing 5' of standard 4', so as to rotate within the same, and upon that part of the sleeve which projects beyond the bearing is keyed the compound gear 19. The latter is composed of a pinion 20 and a bevel-gear 21, and a rather large bevel-wheel 22, mounted upon a shaft 23 below platform 1, meshes with pinion 20.

A small bevel-gear 24 meshes with gear-wheel 21, and to the shaft of gear 24 are secured fans 25, which are thus driven at a high speed and serve as a regulator, as will be readily understood by those skilled in the art.

A weight 26 is suspended by cords or chains 27 from shaft 23, and if said shaft is turned by a crank 28, or otherwise, in one direction the cords or chains are wound upon the same, as indicated in Fig. 1, and the weight 26 is raised up toward the platform. If, on the other hand, the weight is allowed to descend, it will rotate shaft 23, this in turn will rotate gear-wheel 22, which, meshing with pinion 20, will rotate the latter and the connected shaft 6, and in the manner hereinbefore described support 7 will receive a rectilinear motion, while flange 10, upon bevel-gear 9, will both rotate and move in a straight line. For every complete revolution of bevel-gear 14 support 7 and bevel-gear 9, with its connected flange 10, will be moved in the line of a diameter a distance equal to the pitch of the screw-threads upon shaft 6, and it will now be understood that if a plate 13 is fixed to flange 10 and a fixed pencil or stylus be lightly pressed upon the plane surface of said plate a spiral line will be drawn upon the plate.

The recording-stylus 29 is mounted upon a diaphragm 30, and the diaphragm itself, which may be of any suitable sonorous material, is mounted in a case 31, and a rigid tube 32, projecting from one side of the case, communicates with a flexible tube 33 and a mouth or ear piece 34. The tube is clamped and may be adjusted in the direction of its length in a ring 35, formed at the end of a rod 36, which is adjustable in a support 37, and the latter is again adjustable vertically in a standard 38 mounted upon platform 1. A metal post 39 is fixed to the center of the diaphragm, as shown, and its free end has an axial slot 40, into which a soft-rubber tube 41 is forced and flattened. The free end of the soft-rubber tube receives the stylus 29, which may be of metal or any other hard and fairly elastic material.

Preferably the stylus is made of a flat strip of phosphor-bronze extending radially over the face of casing 31 and some distance beyond the edge of the same. At its free end the stylus is reduced to a point and is curved upwardly, and by turning the diaphragm-case about the axis of tube 32, or by turning rod 36 in its bearing 37, or by adjusting the latter upon bracket 38 the point of the stylus may be brought into light contact with the lower face of disk 13 at a point in the diameter of said disk which is parallel with shaft 6.

Near the middle of its length a hole is produced through the stylus, and a pin 42, formed at one end of a metal block 43, passes through said hole and into the central bore in a similar block 44. Between each block and the adjacent face of the stylus a soft-rubber washer 45 is inserted, and the two blocks are forced together and are made to clamp the stylus between the rubber washers by means of the pointed screws 46, working in the supports 47. The screws 46 46 thus constitute the pivotal supports of the stylus, which is a true two-armed lever. A piece of soft-rubber tubing 48 is inserted between the outer arm of this lever and the casing 31, and another piece of soft-rubber tubing 49 is slipped over the stylus between the elastic support 48 and the outer end. Thus it will be seen that the stylus is elastically supported and amply dampened, and that if the diaphragm vibrates under the impact of sound-waves the free end of the stylus will move to the right and to the left of its position of rest and parallel to the face of disk 13.

The disk 13 is preferably made of glass. It is of suitable diameter and thickness, and has two holes 12' 12', corresponding to the pins 12 12 projecting from flange 10, and is placed in position upon said flange with the pins entering the holes. The nuts 50 50 are then screwed down, whereby the glass disk is securely clamped.

The method of recording and reproducing recorded sounds by means of this apparatus will now be easily understood.

As has been stated above, the non-resisting material upon which the sound-record or phonautogram is produced is a semifluid, and I can use for this purpose any ink, as, for instance, printers' ink, of the required consistency. An even layer of this ink may be spread over the under surface of the glass disk in any suitable manner, as, for instance, by means of a brush or roller while the disk is slowly turned; but I prefer to produce the ink directly upon the disk itself, and I proceed in the following manner: The under surface of the glass disk is first carefully polished and dried, and is then covered with a thin film of oil by means of a camel's-hair brush. This is done while the disk is rotated with moderate speed. Any oil or fat may be used, but I have found linseed-oil specially adapted for the purpose. A smoky flame is then held under the glass plate while the latter is slowly rotated, whereby the lampblack ascending from the flame is intercepted by the plate and becomes deposited upon the same in a very fine layer, which, however, is instantly absorbed by and mixes intimately with the thin layer of oil, thus forming a black amorphous ink, covering the under surface of the glass disk in an even exceedingly thin layer. It is essential that the lampblack be deposited upon the oiled disk by the described process of sublimation; that is to say, the carbon particles must reach the disk and mix with the oil at the moment when their transition from the gaseous into the solid state takes place. If it were attempted to apply lampblack already formed by dusting upon the oiled disk, no intimate mixture resulting in an even layer of amorphous ink would be obtained. The coating of ink thus directly formed upon the disk has just the consistency and the thickness required. It will not flow spontaneously, and while it adheres well to the glass plate, it requires only a minimum force to remove it from the same, and the point of the stylus in its passage through the substance of the ink experiences no perceptible resistance. The disk is now ready to receive the phonautogram, and it is moved to the position shown in Fig. 1, with the point of the stylus near the outer edge. The point of the stylus is then adjusted into light contact with the disk, so that the coat of ink is barely penetrated by the same, and the weight 26 is allowed to descend and to rotate shaft 6 in the manner hereinbefore described. If now the stylus remained immovable, it would describe upon the under surface of the disk a smooth spiral the convolutions of which continuously decrease toward the center of the disk. The pitch of the spiral is determined by the pitch of the screw upon shaft 6 and by the relative angular velocities of said shaft and of bevel-gear 9, and may in practice be made as small as one-fiftieth of an inch. If now during the progress of the disk sound-waves are directed against the diaphragm through the mouth-piece 34 and tubes 33 and 32, the stylus will vibrate to the right and left of the spiral line, inscribing upon the disk an undulatory line of even depth, which line will truly and accurately represent the sounds uttered against the diaphragm. The stylus removes a very sharp line of ink from the disk, leaving the latter quite transparent at this line, while it is quite opaque and will not transmit light at the places not touched by the stylus. The ink removed by the stylus drops away from the disk, as stated above, and does not accumulate in and about the grooves.

An approximate idea of the phonautogram thus produced can be obtained by inspection of Fig. 9, which represents an undulatory spiral line upon a disk, with the pitch of the spiral and the undulations of the record greatly exaggerated. In the drawings, the undulatory line appears black upon a white ground, while in fact the line is transparent upon a black ground.

The phonautogram may extend to within a short distance from the edge of flange 10, and in practice the cords or chains 27 27 are made just long enough to drive the disk up to that limit, or the apparatus is mounted at the proper height above the ground so that the weight will be arrested before the limit of progress of the disk is reached. Bevel-gear 14 is then disengaged from bevel-gear 9 by unclamping the same from shaft 6 and sliding it upon the same a short distance to the left hand, (in the view shown in Fig. 1,) and the disk is then given a single rotation by hand, whereby the stylus describes a true circle 51 upon the disk. This circle, which I call the "centering-circle," is afterward utilized, as will presently appear. The glass disk, with the sound-record and centering-circle upon the same, is now removed, and the record may be fixed by applying a thin coat of varnish. It may then be handled with impunity. From this record I produce a copy in copper or any other metal by the process of photo-engraving, and in this process I use the original record as a negative, which enables me to work by transmitted light and with parallel rays, the negative being applied directly in contact with the sensitive photographic plate. The copy thus produced will have the exact size of the original, as is well understood by those skilled in the art. In the photo-engraved copy the sound-record appears as an undulatory line of even depth upon a solid metal disk, and the centering-circle 51 is reproduced in the same manner.

For reproducing the original sounds, the center of the centering-circle is determined by well-known simple geometrical constructions, and a small hole is drilled through that center, which hole corresponds to the mathematical axis about which the glass disk had been rotated, and also marks the axis about which the metal disk must be rotated by the apparatus shown in order that the pointed stylus applied to the starting-point of the record may follow the same from beginning to end. Two holes corresponding to the holes 12' 12' in the glass-disk are also made in the metal disk, but these holes are preferably made large enough to permit the disk to be adjusted in either direction when placed upon flange 10. Before this is done a well-fitting cylindrical block 52 is placed into that part of the cylindrical hole through the common center of flange 10 and bevel-gear 9 which is occupied by the head of screw 11, as shown in Fig. 8. This block, which I call the "centering-block," has a fine axial hole 53, which corresponds exactly to the mathematical axis of rotation of bevel-gear 9. If now the photo-engraved copy of the record is placed upon flange 10, with pins 12 12 passing through corresponding holes in the metal plate, a fine pin, say a sewing-needle, is passed through the centering-holes in the disk and in block 52, and the clamp-nuts 50 are tightly screwed down. By this simple process the metallic copy of the original record is safely and quickly centered in position. The stylus is then adjusted with its point in engagement with the outer end of the record-groove, and the weight 26 is allowed to descend. It will now be clear that the stylus will be forced positively to follow the undulations of the record, and that the diaphragm vibrating under the stylus will emit the same sounds which produced the original record, which sounds can be distinctly heard at the ear-piece 34.

Both the process and the apparatus thus far described may be modified in various ways without departing from the main features of my invention. So, for instance, I can dispense with the centering device and can rotate the record upon a stationary axis, if the diaphragm with its attached stylus is mounted in a manner to make it follow the spiral record. An arrangement of this character is shown in Fig. 10. The reproducing-disk 54 is in this case mounted as hereinbefore described, but without regard to the centering device. The support 7' may be fixed in position so that the bevel-gear 9, mounted upon the same in the manner described with reference to Fig. 3, will turn without progressive motion. Bevel-gear 9, and with it the reproducing-disk 54, are rotated by a bevel-gear 14' upon a shaft 6', to which power is applied by a weight, as shown, or in any other suitable manner. The diaphragm-casing 31 is secured to a small truck 55 upon rails 56 arranged vertically above and parallel with a diameter of the reproducing-disk, and at such height above the same that the stylus 29 will be in engagement with the undulatory grooves of even depth which represent the record of sounds.

The listener applies his ear to the ear-piece, and when the shaft 6' is rotated the stylus and diaphragm will be forced to vibrate, as in the apparatus shown in Fig. 1, but will at the same time move with the truck 55 across the face of disk 54. A tolerably good reproduction may also be obtained by simply holding one end of a reed between the teeth and the other pointed end of the same in engagement with the record-grooves while the disk is rotated.

The frictional contact of the reproducing-stylus with the surface of the ordinary metallic record gives rise to disturbing sounds, and with a view of avoiding the same I mount the reproducing-disk 54 (see Fig. 11) upon a rigid plate 58, and with a sheet 57, of felt, soft rubber, blotting-paper, or other nonsonorous substance intervening. This dampens the extraneous vibrations of the reproducing-disk and renders the sounds emitted by the diaphragm very clear.

Additional clearness is obtained by nickel-plating the metallic record, which is ordinarily made of copper, since I have found that the sound due to the frictional contact of the stylus with a polished surface of nickel is very faint.

In place of the metallic copy of the original record I can use a copy made or sealing-wax, which is made from a metallic or other copy having the record in raised lines. The metallic copy is for this purpose first oiled and the molten sealing-wax is then poured over it and is then backed by plaster-of-paris or other rigid material. The cast is then easily removed from the metallic matrix and may be used for the reproduction of the recorded sounds, which will be quite clear and remarkably free of the disturbing sounds due to the friction of the stylus, especially when the surface is first gently rubbed with plumbago.

The metallic copy of the original record is in effect an engraved copper plate, and it may be used as such for printing upon paper, which then yields a copy in raised lines, as is well understood, and from this paper copy the sealing-wax copy or a copy of any other similar material may be made.

I desire to emphasize the fact that my recording and reproducing stylus is a flat elastic strip, which will yield in one direction, but not in the other. For this reason the recording and reproducing surface need not be absolutely plane, and the stylus will still retain contact with the same, while it will be positively moved to follow the undulations of the record in reproducing. The point of the stylus may be made of iridium.

Having now fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The method of producing a phonautogram, which consists in removing an undulatory line of even depth of a deposit of ink from a traveling plate, by and in accordance with sound-vibrations; substantially as described.

2. The method of producing a phonautogram, which consists in removing an undulatory line of even depth of a deposit of amorphous ink from a traveling support, by and in accordance with sound-vibrations; substantially as described.

3. The method of producing a transparent phonautogram, which consists in removing an undulatory line of even depth of a deposit of ink from a traveling plate of glass, by and in accordance with sound-vibrations; substantially as described.

4. The method of producing a transparent phonautogram, which consists in removing an undulatory line of even depth from a deposit of amorphous and opaque material from a traveling support of glass, by and in accordance with sound-vibrations; substantially as described.

5. The method of producing a transparent phonautogram, which consists in removing an undulatory line of even depth extending along a volute, of a deposit of amorphous and opaque material from a rotating disk of glass, by and in accordance with sound-vibrations; substantially as described.

6. The method of producing a layer of semifluid ink upon a phonautographic support, which consists in first applying a coat of oil, or other fat, upon the support, and then sublimating upon the oiled surface a thin layer of lampblack; substantially as described.

7. The method of producing a phonautogram, which consists in removing an undulatory line of non-resisting material from the under surface of a traveling plate, by and in accordance with sound-vibrations; substantially as described.

8. In a gramophone, the combination of a sound-receiving sonorous body; with a pivoted stylus controlled by and controlling the same, and a support adapted to carry a phonautogramic recording-surface, or a copy of such record in solid resisting material, traveling in the plane of vibration of the point of the stylus; substantially as described.

9. In a gramophone, the combination of a sonorous diaphragm and a pivoted stylus; with an elastic connection between the diaphragm and stylus, and an elastic reactionary dampening-support for the free arm of the stylus; substantially as described.

10. In a gramophone, the combination of a pivoted stylus, with an elastic connection between the diaphragm and the stylus; substantially as described.

11. In a gramophone, the combination of a vibratory diaphragm and a stylus controlled thereby and controlling the same; with a rubber tube clamped to the diaphragm and connecting the stylus with the latter, and a pivoted support for the stylus between its free end and its connection with the diaphragm; substantially as described.

12. In a gramophone, the combination of a vibratory diaphragm and a stylus elastically connected therewith; with a pivoted support for the stylus located between the free end of the same and its connection with the diaphragm; dampening-washers between the stylus and its pivotal support, and a reactionary dampening-support for the free arm of the stylus; substantially as described.

13. In a gramophone, the combination of a horizontal traveling support for the record-surface; with a vibratory diaphragm, and a recording-stylus bearing upon the under surface of the support; substantially as described.

14. In a gramophone, the combination of a

metallic record of spoken words or other sounds; with a backing of non-resonant material; substantially as described.

15. In a gramophone, the combination of a sound-receiving diaphragm, mounted in a suitable casing; with a tubular sound-conveying stem projecting from the casing, and an adjustable support for the tubular stem; the connection between the casing and tubular stem being such as to permit of the rotation of the casing relative to the stem for adjustment, substantially as described and for the purpose set forth.

16. A device for centering a spirally-extending record, of sounds upon a reproducing apparatus, consisting of a rotatable record-support having a central recess, a block fitting the said recess and having a perforation coincident with the mathematical center of rotation of the record-support, and means for holding the record upon the support, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EMILE BERLINER.

Witnesses:
JACOB G. COHEN,
CHAS. W. HANDY.

**No. 645,920.** **Patented Mar. 20, 1900.**

## T. B. LAMBERT.

## METHOD OF REPRODUCING PHONOGRAPH RECORDS.

(Application filed Aug. 14, 1899.)

**(No Model.)**

Fig. 1.

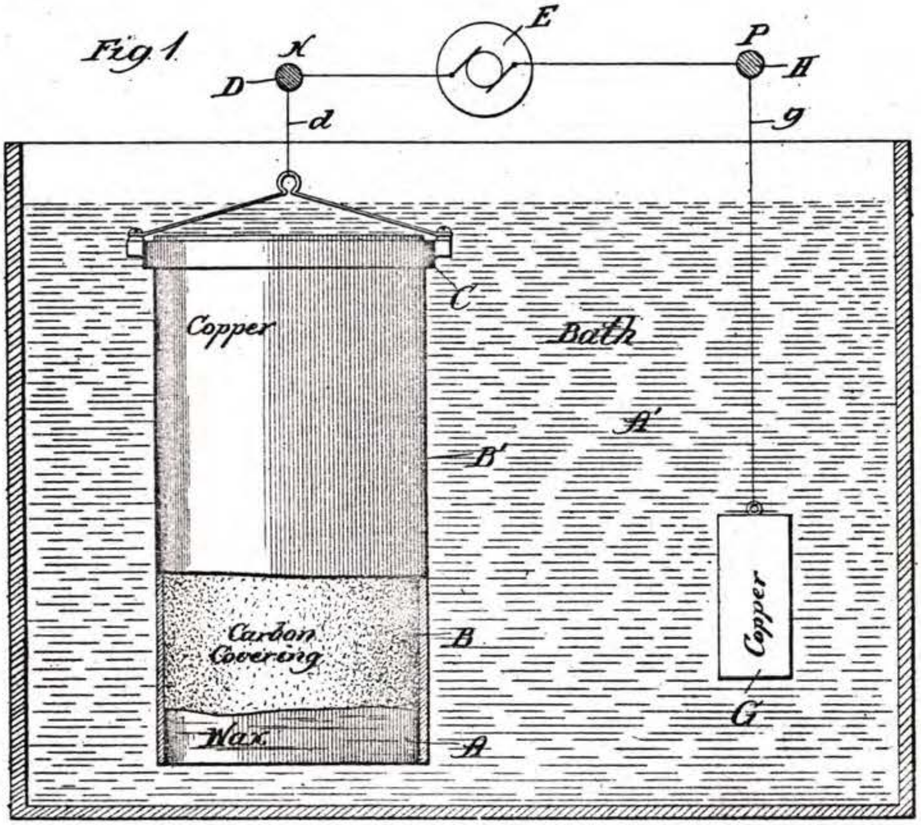


Fig. 2.

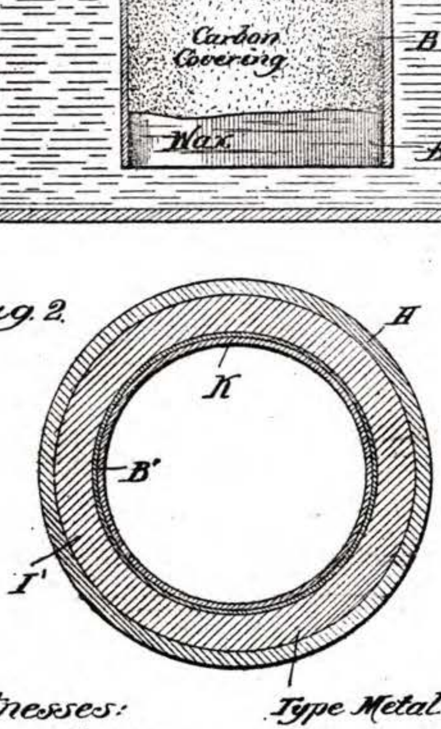
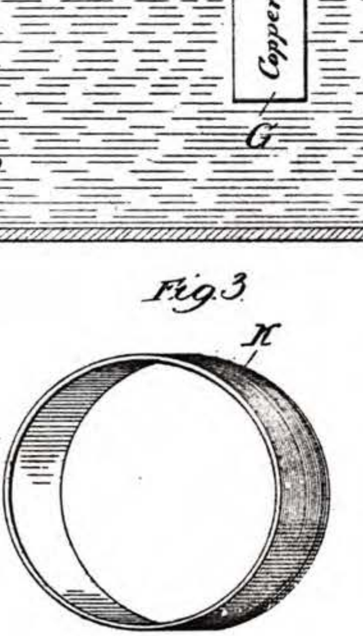


Fig. 3.



Witnesses:

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Thomas B. McGregor

Inventor.

Thomas B. Lambert,

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Attys.

# UNITED STATES PATENT OFFICE.

THOMAS B. LAMBERT, OF CHICAGO, ILLINOIS, ASSIGNOR OF THREE-FIFTHS
TO BRIAN F. PHILPOT AND JOSEPH POWELL, OF SAME PLACE.

## METHOD OF REPRODUCING PHONOGRAPH-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 645,920, dated March 20, 1900.

Application filed August 14, 1899. Serial No. 727,183. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS B. LAMBERT, a citizen of the United States, residing at Chicago, Cook county, Illinois, have invented certain new and useful Improvements in Processes for Producing Record-Cylinders for Phonographs, of which the following is a specification.

My invention relates to that class of mechanisms which are styled "record-cylinders" and which are adapted to be used in connection with phonographs and similar instruments—that is, instruments adapted to be operated for the purpose of vibrating a diaphragm and imitating speech and musical notes.

The invention relates particularly to a cylinder and the material of which it is formed, so as to render it of excessive longevity by the use of material practically infrangible, and, further, to the means, methods, or processes by which this and duplicate cylinders may be produced, all of which will more fully hereinafter appear.

The principal object of my invention is to provide a simple, economical, and efficient method for constructing infrangible record-cylinders.

A further object of the invention is to provide a record-cylinder of such material as to render it practically infrangible; and the invention consists in the methods, features, combinations, and details of construction hereinafter described and claimed.

In the drawings, Figure 1 is a vertical sectional elevation of a bath containing an electrolytic solution adapted to electrically form a matrix by which a record-cylinder for phonographs may be produced, showing other elements attached, as will be more fully hereinafter explained; Fig. 2, a plan view of a completed matrix, and Fig. 3 a perspective view of a completed record-cylinder.

In the art to which this invention relates it is well known that it is desirable to produce a record-cylinder of such nature and construction as will make it practically indestructible, and, further, to provide means and methods by which such a cylinder can be economically and efficiently formed and duplicated in quantities as desired. To these features my invention principally relates.

In forming a record-cylinder I first take and make an impression upon a wax cylinder A (see Fig. 1, in which the wax cylinder is in the bath) in an ordinary phonograph, and then remove this wax cylinder from the phonograph and provide it at one end with a coating of carbon B or other electric conducting material. I next place this cylinder in an electrolytic bath, having first surrounded and connected it with a metal ring C, which is supported on a metal rod D by means of a wire *d* and connected with the negative pole of a dynamo E. This cylinder, with its attached mechanism, is then placed, as above suggested, in the electrolytic bath, which brings it in circuit with the anode G, of copper or other metal, hung by means of a metal wire *g* upon a metal rod H and connected with the other pole of the dynamo. The dynamo being started, the copper is electrically deposited upon the carbon-coated wax cylinder, and after it has reached the desired thickness forms a copper cylinder, which is then removed from the bath and disconnected from the dynamo. The wax is next shrunk by means of cold application, so that the copper cylinder may be removed therefrom. These operations form a copper cylindrical matrix $b'$, the inner cylindrical surface of which contains a counterpart of the impressions on the wax cylinder. It is desirable now to produce the indestructible record-cylinders from this copper matrix in quantities as desired. To accomplish this result, the matrix is placed inside of a metal ring I, considerably larger in diameter than the matrix, and the space between the same filled with type-metal I', which securely locks the matrix in position and furnishes a firm backing for the same. I next take a soft ring of cellulose or vulcanized rubber, either in a raw or partially-cured state or previously softened with some solution and of sufficient thickness to receive in perfect form the indentations of the matrix and at the same time furnish a suitable backing or support for the phonographic reproduction of the record. This relatively-thick ring or tube is then placed within the cylindrical opening of the matrix and by means of an expansive pressure with heat forced outwardly, completely filling the matrix and against the inner surface thereof, thus making a counterpart of the same and a record similar to that on the original wax cylinder. The ring thus formed, having on its outer face a faithful imprint of the matrix, is then allowed to harden, either naturally or by artificially curing the substance thereof, through which hardening it shrinks sufficiently to enable its subsequent removal to be made from the matrix without injury to either. As a shrinking or reducing medium I have used a solution of hydrochlorous acid and water in which the tube and matrix are placed, as above, so that the tube can be removed from its engagement with the matrix. When it has become dried and hardened, it forms a cylinder K, as shown in perspective view in Fig. 3, preferably of cellulose, and which is practically infrangible. I prefer to use cellulose for this purpose in that it is easier to manufacture and more durable in operation, though the same method may be used for forming cylinders of different materials.

In carrying out my process it is an absolute requirement that the blank phonograms or tubes must be of a thickness to receive and retain in a perfect form the indentations of the matrix and at the same time have within itself a sufficient backing or support for the reproduction of the record phonographically after the formation of the record on its face and the removal of the tube from the matrix. It is practically impossible to use very thin walled tubes or hollow cylinders for my process, because the phonographic reproduction of sound from such thin records, supposing the tubes to be capable of even temporarily maintaining or holding their shape, would be weak, distorted, indistinct, and imperfect; but as a matter of fact the records themselves made of thin material are not capable of retaining their shape and would be impractical in actual use. By using a relatively-thick-walled tube or hollow cylinder the objections which would occur in practice with a very thin tube are entirely overcome and the produced records are a merchantable article. It is to be understood that in applying pressure to the interior of the tube or cylinder for forcing the same outwardly and against the face of the matrix such pressure must be simultaneously exerted over the entire surface of the tube or cylinder and in a uniform manner, so as to simultaneously force the entire exterior surface against the interior face of the matrix, for if otherwise there would be great danger and liability of a flow of material and a consequent distortion therefrom, producing an imperfect record.

I claim—

1. The method of producing record-cylinders for phonographs, which consists in first forming a record on a cylinder of wax or other relatively-soft material, rendering the surface of the wax cylinder electrically conductive and electrolytically depositing metal thereon, forming a matrix and then outwardly expanding under pressure within the matrix, a cylinder or tube of softened material sufficiently thick to maintain its shape during and after the act of disengagement from the matrix and finally removing the cylinder or tube by direct longitudinal movement, substantially as described.

2. The method of producing record-cylinders for phonographs which consists in first forming a record on a cylinder of relatively-soft material such as wax, then coating such cylinder with carbon or other electric conducting material, and electrolytically depositing metal thereon forming a matrix, then shrinking the soft cylinder to remove the electrically-formed matrix and backing such matrix to form a matrix-mold, then outwardly expanding under pressure a cylinder or tube sufficiently thick to maintain its shape after disengagement from the matrix and of softened material such as cellulose, within the matrix for the pressure to reproduce on the outer surface the counterpart of the indentations in the matrix, then allowing such cellulose cylinder or tube to harden within the matrix and removing the record cylinder or tube from the matrix and then drying and hardening the record-cylinder, substantially as described.

THOMAS B. LAMBERT.

Witnesses:
THOMAS F. SHERIDAN,
ALBERT D. PHILPOT.

**No. 650,431.** **Patented May 29, 1900.**

# G. H. STEVENS.

## PROCESS OF DUPLICATING PHONOGRAMS.

(Application filed Feb. 2, 1899.)

(No Model.)

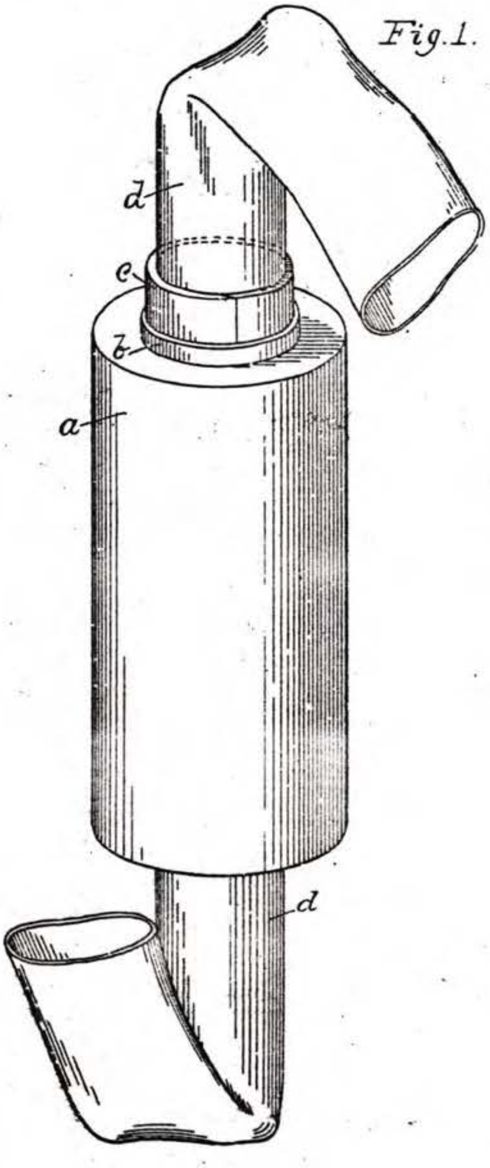
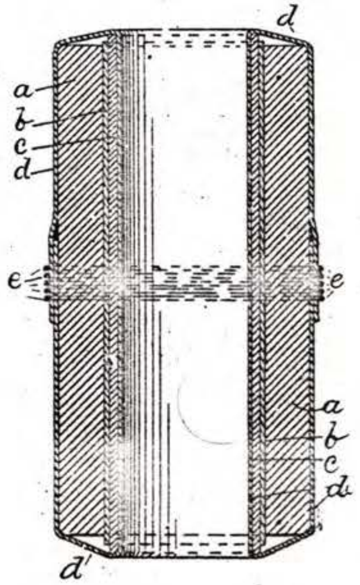


Fig. 1.

Fig. 2.



WITNESSES:

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INVENTOR:

George H. Stevens,

By [illegible] Hall

His Attys.

# UNITED STATES PATENT OFFICE.

GEORGE H. STEVENS, OF TOLEDO, OHIO.

## PROCESS OF DUPLICATING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 650,431, dated May 29, 1900.

Application filed February 2, 1899. Serial No. 704,232. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE H. STEVENS, a citizen of the United States, residing at Toledo, Lucas county, Ohio, have invented a certain new and useful Process of Duplicating Phonograms, of which the following is a specification.

In the reproduction of cylindrical sound-records for phonographs and analogous machines the results have proved unsatisfactory, owing to the soft and frail nature of the material employed. It is found that these records are easily scratched, defaced, marred, or broken, that they wear out quickly, and are not convenient for shipping unless extraordinary care is taken in packing them. To obviate these objections, I duplicate the record upon material that is so hard, tough, and flexible that it will take an impression only under hydrostatic or some other very high pressure. It is also found that the duplication of these cylinders is slow, laborious, and expensive and that their efficiency is diminished with each successive reproduction from the original. These difficulties and objections are due to the fact that heretofore no successful method has been devised for forming upon a seamless cylinder of hard tough resisting material a perfect cast or impression from a seamless mold or matrix containing the sound-record, because the withdrawal of such cast or impression from a seamless matrix would break down and destroy the delicate wave-lines of the sound-record either in the matrix or the reproduction, or both.

My invention relates to and one object is by the method or process hereinafter described to provide a seamless cylindrical duplicate of a cylindrical phonogram or sound-record, which record may be composed of hard tough resisting material, to prepare the same from a seamless matrix, and to make these reproductions in such manner that the matrix may be used over and over indefinitely without apparent deterioration.

The further object of my invention is to provide phonograms of the character described which shall be effective, cheap, light, durable, capable of being roughly handled without breaking or spoiling the same, and capable of being packed or nested in very small compass either by constructing the same in slightly-conical form or in cylinders of various diameters.

To this end the first step in my process consists in electrically depositing upon and around the usual cylindrical wax record an electrotype matrix or mold, first depositing a thin shell of nickel upon the wax and then depositing upon this a heavy shell of copper, the purpose of the nickel being to give to the interior face of the matrix a smooth surface that does not easily tarnish, that is harder than copper, and that will produce a higher polish upon the surface of the phonogram or record that is afterward pressed therein. Now from this matrix or mold the substance of which the original record is formed is entirely removed by melting or otherwise. The second step in my process is to introduce into the hollow of the matrix a thin closely-fitting cylinder of any hard tough resisting material having sufficient flexibility to allow it to bend without breaking. In practice I prefer celluloid. Sheet-celluloid may be readily obtained in the markets as thin as one one-hundredth of an inch and should be formed into thin flexible cylinders without joints or seams and of the proper diameter. If the finished and perfect cylinder-blanks cannot be readily obtained, they may be formed out of flat celluloid sheets cut of proper size to make a blank cylinder having a lapping joint of, say, one-eighth of an inch, more or less. The lapping surfaces when moistened with alcohol or ether will soften sufficiently to readily and firmly unite with each other when dry, and these edges when dried under pressure are smoothly and perfectly welded. Any unevenness or exposed edge may be readily dressed off in a lathe to a smooth and even surface, leaving the exterior surface of the cylinder without break or seam. Into this thin flexible cylinder is inserted a closely-fitting thin spring-brass cylinder longitudinally cut or split along one of its sides. When the edges of this piece are brought together, the outer surface is smooth and has the contour of the cylinder. When one of the edges is pressed inwardly out of line, the piece may be collapsed somewhat, so that it may readily be withdrawn from the cylinder. The celluloid blank, with its metal backing, is now slipped into the matrix or mold, which exactly fits the blank when in place. I provide the matrix and its contents with a flexible water-tight jacket or covering. This may be conveniently accomplished by drawing through the hollow of the inner brass cylinder a piece of soft-rubber tubing considerably longer than the matrix and then turning the ends of the tube backward upon the outside of the matrix, so that the ends of the soft-rubber tubes are turned inside out and overlap each other. The rubber envelop thus formed may be secured against leak by winding with wire the overlapping portions of the tube or by clamping the same with a suitable band. I next subject the matrix and its contents to hydrostatic pressure. To accomplish this, I prefer to use a hydraulic "gun," which consists of a chambered piece or pieces of suitable metal constructed of necessary strength and having its chamber connected with a hydraulic pump of the required power. The hydraulic gun is also provided with a steam-jacket properly connected for heating the gun and its contents. In the chamber of this gun liquid-pressure is always uniform in all directions, and great compression may be obtained upon anything that may be contained therein when the interior of the object to be compressed is properly protected from access of the liquid employed in the gun. The matrix (or several of them) and its contents, inclosed in the water-tight flexible envelop, are placed inside the hydraulic gun, which is suitably closed and filled with water or other liquid. The contents of the gun are now subjected to hydrostatic pressure, which acts equally in all directions upon the soft-rubber covering. Its effect, therefore, is to force the rubber against the spring-brass cylinder and the spring-brass cylinder against the celluloid blank, which in turn is compelled to expand slightly, and is thus forced against the interior face of the matrix. There will now be embossed or molded or stamped on the surface of the celluloid the reverse impression of the matrix itself, thus producing an exact duplicate of the original wax record. Although the spring-brass backing may be omitted, better results are obtained from its use. The office of the spring-brass cylinder is to firmly apply the liquid-pressure to the celluloid blank with a less yielding face than would be the case if the pressure were applied directly to the rubber and celluloid. It will be seen that by reason of the liquid-pressure in the gun acting equally and uniformly in all directions, and as the external and internal pressure on the matrix is the same, the matrix is preserved from crushing, breaking, or distortion. To further assist the process of pressing, as soon as a light pressure of, say, two thousand pounds to the square inch has been applied steam is allowed to fill the steam-jacket until the gun and its contents are well heated. This causes the blank of celluloid or the like to become in consequence more plastic and yielding than when cool, and it will under this condition mold easier when the heavier pressure is later applied. As soon as the blank has become hot further pressure is applied to the gun by the hydraulic pump. The steam when properly manipulated through the jacket will then by expansion increase the pressure within the gun until the registering-dial will indicate, say, from fifteen thousand to fifty thousand pounds pressure per square inch. The former figure is generally sufficient for a fair effect; but the nearer the latter figure is approached the more satisfactory are the results. The time necessary for the entire operation of pressing occupies usually from one to two hours. When a proper pressure has been exerted for a sufficient time, the steam is turned off from the steam-jacket, which allows the contents of the gun to cool and contract somewhat, thus lowering the pressure. Now the pressure should be kept up by the pump until the gun and its contents have become cooled, for in embossing and pressing compositions under heat best results are obtained by allowing the material to become cool while yet under full pressure. Instead of employing a hydraulic gun in the pressing process the matrix may be made very strong and provided with means for capping or sealing its ends hermetically, the whole being constructed to withstand a sufficient interior pressure without a corresponding exterior one. This matrix should be provided with a steam-jacket, and inside of the matrix should be a rubber bag attached to the hydraulic connection, so that when the liquid-pressure is applied moisture will be excluded from the interior of the matrix, the cylinder, and the cylindrical spring-brass backing. This device is, however, the obvious mechanical equivalent of the gun or any other means of obtaining interior hydrostatic pressure upon the cylinder. As only comparatively-low pressures can be employed in the modification here suggested, the use of the gun above described is much to be preferred. When sufficiently cool, the chamber of the gun is opened and the matrix and its contents are taken out. The wire or band is now removed from the outside of the rubber (the rubber being stripped off readily, as its adhesion is but slight) and the spring-brass cylinder is collapsed and removed, as above indicated. The inner face of the matrix will be found to have a lining of celluloid or the like firmly and uniformly embedded upon its face, which lining is quite flexible. Now if a stiff blunt small steel wire or other suitable instrument is carefully inserted between the celluloid cylinder and the matrix itself the side of the flexible cylinder can be sprung inwardly, thus reducing the exterior circumference of the cylinder, which permits the cylinder to be readily detached and withdrawn from its matrix or mold without injury to either the mold or the phonogram. It will be seen that from a seamless matrix or mold has been constructed and embossed or stamped a seamless

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record of practically indestructible material, having on its surface an exact reverse impression of the matrix and having such a sharp distinct impression as will cause the usual needle and diaphragm of a talking-machine of the type in question to respond in exactly the same manner as do the original common wax records when new. The thin flexible phonogram, which may, if wished, be formed somewhat tapering, is now slipped onto a suitable hollow mandrel or holder properly constructed for the purpose, and, if desired, may be securely fastened there by some adhesive substance, though preferably I employ a rigid hollow mandrel with a slightly-tapering exterior surface upon which the record may be crowded tightly, said mandrel having an interior face, also slightly tapering, but with a suitable diameter and taper to fit snugly over the usual mandrels with which the various types of talking-machines are usually supplied. The thin flexible record is now ready for use.

In the accompanying drawings, made part hereof, Figure 1 is an elevation of a matrix or mold, a blank and its backing of spring-brass, and a rubber tube in the course of being assembled to receive hydrostatic pressure; and Fig. 2 is a central sectional elevation of the same assembled ready for hydrostatic pressure.

In the drawings, *a* is the matrix or mold; *b*, the blank cylinder; *c*, the inner spring cylinder or backing, and *d* the elastic tube to form the water-tight jacket.

In Fig. 2, *e* represents the wire or band with which the backwardly-turned overlapping ends of the tube *d* are bound and compressed to make a water-tight joint.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The improvement in the process of forming a duplicate cylindrical phonogram of plastic material from an electrotype-matrix, which consists in introducing into the plastic cylinder an expansible backing of solid material.

2. The improvement in the process of forming a duplicate cylindrical phonogram of plastic material from an electrotype-matrix, which consists in introducing into the plastic cylinder an expansible backing of solid material, then excluding moisture from the matrix and its contents, and then subjecting the backing of solid material to internal hydrostatic pressure.

3. The method or process of duplicating cylindrical phonograms which consists in forming a seamless electrotype matrix or mold from the phonogram to be duplicated; then introducing into said matrix a flexible blank cylinder of hard, tough material having a solid backing separable therefrom, then excluding moisture from the face of the matrix, the blank and its backing, and then applying hydrostatic pressure to the interior of the blank and its backing, substantially as described.

4. The method or process of duplicating cylindrical phonograms which consists in forming a seamless electrotype matrix or mold from the phonogram to be duplicated, then introducing into said matrix a hollow, blank cylinder having a separable solid backing, and then applying hydrostatic pressure to the interior of said backing, substantially as described.

5. The method or process of duplicating cylindrical phonograms which consists in forming an electrotype seamless matrix from the phonogram to be duplicated, then introducing into said matrix a blank of hard tough flexible substance having a separable solid backing, then applying hydrostatic pressure to the interior of the blank and its backing, and then separating the matrix, the phonogram thus produced, and its backing, substantially as described.

6. The method or process of duplicating cylindrical phonograms which consists first, in forming an electrotype seamless matrix or mold from the phonogram to be duplicated; second, introducing into said matrix a thin flexible blank cylinder having a suitable backing of solid material; third, excluding moisture from the face of the matrix and the blank; fourth, applying hydrostatic pressure to the interior of the blank and its backing, and fifth, separating the matrix, the phonogram thus formed, and its backing, substantially as described.

GEORGE H. STEVENS.

In presence of—
JOHN R. BOWLAND,
L. E. BROWN.

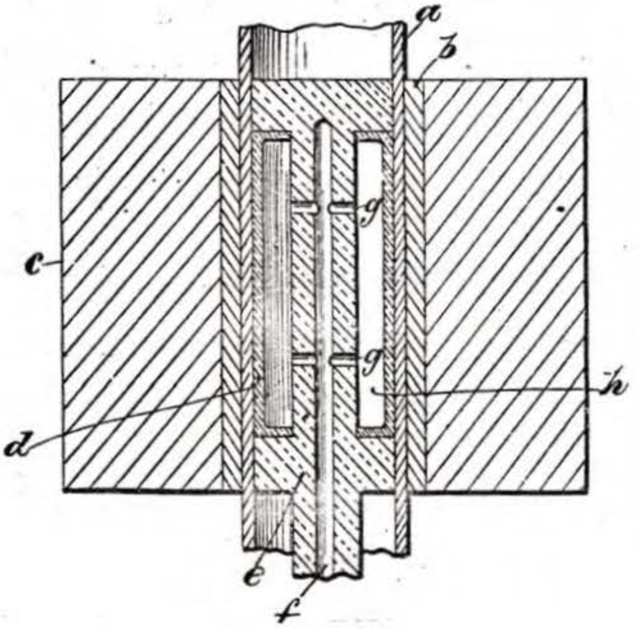
No. 650,739. Patented May 29, 1900.

## H. G. WOLCOTT.

## METHOD OF DUPLICATING PHONOGRAPH RECORDS.

(Application filed Mar. 22, 1900.)

(No Model.)



Witnesses.
Robert Everett

Inventor:
Henry G. Wolcott,
By James L. Norris
Atty.

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# UNITED STATES PATENT OFFICE.

HENRY GOODRICH WOLCOTT, OF FISHKILL-ON-THE-HUDSON, NEW YORK.

## METHOD OF DUPLICATING PHONOGRAPH-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 650,739, dated May 29, 1900.

Original application filed July 25, 1899, Serial No. 725,060. Divided and this application filed March 22, 1900. Serial No. 9,780. (No model.)

*To all whom it may concern:*

Be it known that I, HENRY GOODRICH WOLCOTT, a citizen of the United States, residing at Fishkill-on-the-Hudson, in the county of Dutchess and State of New York, have invented a certain new and useful Improved Method of Manufacturing Phonogram or Gramophone or Phonograph Duplicates from a Negative of the Original Record, of which the following is a specification, which is a division of the invention contained in my application for Letters Patent filed July 25, 1899, Serial No. 725,060.

This invention relates to an improved method of manufacturing phonogram or gramophone or phonograph duplicates from a negative of the original record; and it consists in supporting within a negative bearing a cameo reproduction of the sound-waves taken from the surface of the original record a cylinder of plastic material or material capable of being rendered plastic by the application of a gentle heat and expanding or forcing the plastic cylinder circumferentially outward into intimate contact with the cameo face of the negative by the action of a fluid expanding agency within the plastic cylinder.

The invention also consists in exteriorly supporting a negative bearing a cameo reproduction of the sound-waves taken from the surface of the original record, a cylinder of plastic material or material capable of being rendered plastic by the application of a gentle heat, and expanding or forcing the plastic cylinder circumferentially outward into intimate contact with the cameo face of the negative by the action of a fluid expanding agency within the plastic cylinder.

In the accompanying drawing I have illustrated one form of apparatus suitable for carrying my invention into effect, in which said apparatus is illustrated in central longitudinal section.

I will describe my said improved method in connection with said illustrated apparatus, although I desire it distinctly understood that I do not confine my invention to such apparatus, as the same is not herein claimed, and various other means suitable for performing my improved method may be employed.

In carrying out my invention I take a hollow cylindrical negative *b*, which bears on its interior surface a reproduction in cameo of the sound-waves impressed or cut into the surface of the original record and support it exteriorly, as in a housing *c*, and either before or after said negative is introduced into the external cylinder-support *c* I place within said negative a cylinder or tube *a*, of plastic material or material capable of becoming plastic by the application of a gentle heat and which is preferably of vulcanite, celluloid, or the like, and within the plastic material is introduced a hollow piston *e*, having an elongated annular or circumferential recess which in longitudinal extent is coequal or greater than the surface of the negative on which the cameo reproduction of sound-waves is formed and which recess is covered with a flexible bag *d*, such as rubber, whereby an annular chamber *h* is formed. The piston is provided centrally with a longitudinal bore or passage *f* and lateral ports *g*, discharging into the annular chamber *h*. I conduct into said annular chamber through said bore and lateral ports a fluid expanding medium, preferably compressed air or liquid, which acts to force the bag *d* and plastic cylinder *a* evenly outward in all directions, pressing the latter evenly and gently into intimate contact with the cameo-worked face of the negative and forming in the external surface of said cylinder an exact and true intaglio reproduction of the cameo representations of the sound-waves possessed by the negative, and thus reproducing a true facsimile or exact duplicate of the original record.

The plastic cylinder A is preferably a little smaller in diameter than the internal diameter of the negative, and said cylinder on the reduction of the internal expanding pressure can be readily removed from the negative, owing to its yielding capacity and to the diametrical difference existing between the cylinder and the negative.

In order to secure the production of a duplicate record with merely a moderate internal pressure in the chamber *h*, either the negative or the plastic cylinder, or both, may be gently heated before they are placed into working position, so that the plastic cylinder, and especially its outer surface, will be capable of more readily taking an impression from the negative.

The step of externally supporting the negative, which is preferably an electro, is important to prevent any possible distortion of the negative and to hold the same firmly while the plastic cylinder to receive the intaglio impression is being forced into intimate contact therewith, and the action of the fluid expanding medium operates within the plastic-cylinder surface to force the same outward equally and gently in all directions into intimate contact with the interior worked surface of the negative, resulting in the production of a duplicate record which is a perfect facsimile of the original record. As many duplicates as may be desired may be manufactured in this way.

In the following clauses of the claim I use the term "plastic cylinder" as comprehending a cylinder of plastic material or material which may be rendered plastic by the application of heat, and said claims are drawn to comprehend the introduction of the plastic cylinder into the negative either before or after the latter has been arranged in its external support.

Having thus described my invention, what I claim is—

1. The improved method of manufacturing phonogram, gramophone or graphophone duplicates which consists in arranging a plastic cylinder in a negative having a cameo reproduction of the original sound-wave record, and introducing a fluid expanding agent within said cylinder to force the latter into intimate contact with the interior cameo-surface of the negative.

2. The improved method of manufacturing phonogram, gramophone or graphophone duplicates, which consists in supporting a negative having a cameo reproduction of the original sound-wave record, arranging a plastic cylinder therein, and expanding said plastic cylinder into intimate contact with the interior cameo-surface of the negative by a fluid expanding agent operating within said cylinder.

3. The improved method of manufacturing phonogram, gramophone or graphophone duplicates, which consists in exteriorly supporting a negative of the original record, introducing a plastic cylinder into said negative, and expanding said plastic cylinder into intimate contact with the interior surface of the negative by a fluid expanding medium acting within the cylinder, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

HENRY GOODRICH WOLCOTT.

Witnesses:
H. D. Jameson,
T. L. Rand.

**No. 666,493.** **Patented Jan. 22, 1901.**

### F. L. CAPPS.

### DUPLICATE SOUND RECORD AND PROCESS OF FORMING SAME.

(Application filed Mar. 8, 1899.)

(No Model.)

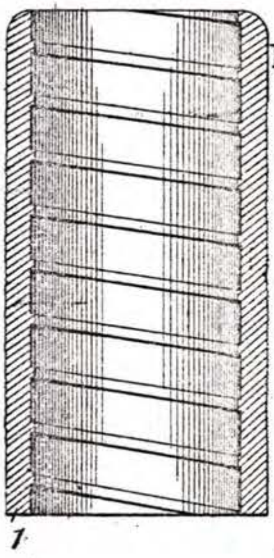


Fig. 1.

Fig. 2.

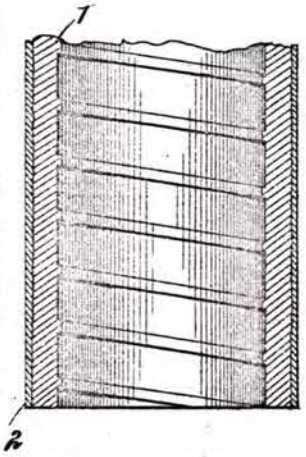


Fig. 3.

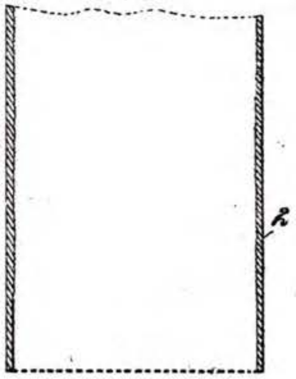


Fig. 4.

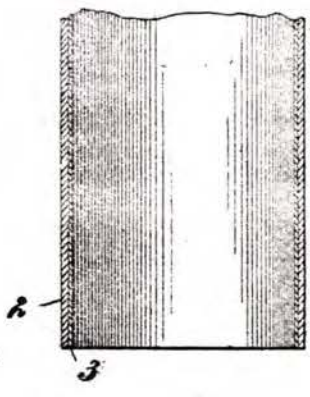


Fig. 5.

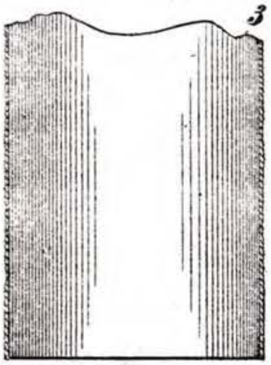
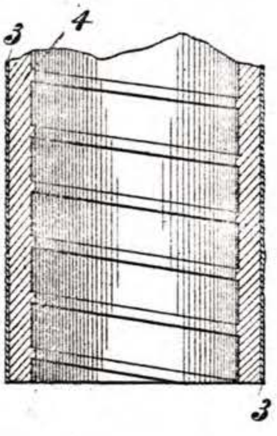


Fig. 6.



WITNESSES

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INVENTOR

Frank L. Capps

BY

Knight Bros

ATTORNEYS

# UNITED STATES PATENT OFFICE.

RANK L. CAPPS, OF NEWARK, NEW JERSEY, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF WASHINGTON, DISTRICT OF COLUMBIA.

## DUPLICATE SOUND-RECORD AND PROCESS OF FORMING SAME.

**SPECIFICATION** forming part of Letters Patent No. 666,493, dated January 22, 1901.

Application filed March 8, 1899. Serial No. 708,183. (No model.)

*To all whom it may concern:*

Be it known that I, FRANK L. CAPPS, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Processes of Forming Duplicate Sound-Records, of which the following is a specification.

The object of my invention is to economically produce and duplicate sound-records.

There are two methods of duplicating sound-records now commonly employed. The first of these methods is the mechanical method, carried out by a suitable duplicating-machine provided with reproducing and recording styli, which respectively follow the record-groove of a rotating master-record and cut a duplication of the record in a correspondingly supported and operated blank. This mechanical method produces a satisfactory duplicate; but a single master-record can be used only a limited number of times, making the cost of the duplicates proportionately large. The other method which is commonly practiced consists in electroplating a master-record, then by suitable means removing the master-record from the electroplate, which forms a cylindrical matrix, backing up the matrix and supporting it in a hot-water or steam warming-jacket, then putting a blank of the proper size within the cylindrical matrix, supporting it therein until it becomes slightly softened by the heat of the surrounding jacket, and then applying a mandrel or former to the softened blank and forcing it into intimate contact with the matrix-surface of the electroplate, and finally removing the electroplate-matrix with attached blank and cooling in a refrigerator to cause the blank to contract so that it may be removed from the matrix. This process also produces satisfactory results, but is a long and tedious process, requiring skilled labor, and although less expensive than the mechanical method this electroplating method is not altogether satisfactory.

My present invention is distinguishable from the above-described processes and the matrices and blanks produced thereby in that my process is a "wet" process or "dipping" process of producing sound-records and my matrices and records are formed in or upon films resulting from the evaporation of a solution of a suitable material.

Broadly considered, my improved process consists in first forming a duplicating-matrix by dipping a master-record in a solution of a suitable material or flowing the solution upon the master-record or otherwise bringing the solution (in a fluid or semifluid state) into intimate contact with the record, then removing the master-record from the matrix, and finally impressing a suitable material into the matrix or electroplating the film-matrix or dipping the matrix into a solution of a desired material or otherwise bringing the solution (in a fluid or semifluid state) into intimate contact with the matrix for the purpose of forming a record. The record so produced is detached from the matrix and may be mounted upon a suitable backing, if necessary, for strength. The duplicating-matrix may be used over and over again an unlimited number of times, as there is practically no wear upon it in making the records.

More specifically, my improved process consists, preferably, in forming a duplicate record by dipping the master-record in or otherwise coating it with a fluid solution of some suitable material, such as gelatin, then allowing the coated record to cool and dry, the gelatin or other suitable material forming a tough and elastic film-matrix upon the master-record, then breaking or otherwise removing the master-record from the matrix formed by the film of hardened gelatin or other material, then dipping the gelatin matrix into the fluid solution of a suitable material, such as celluloid, (or applying to the matrix a backing-sheet of celluloid paper or other material coated with celluloid solution or other impressible material,) then allowing the same to dry, and finally separating the celluloid-film record from the gelatin matrix and applying a suitable strengthing backing to it.

If desired, the celluloid duplicate may be employed as a master-record, from which duplicates are cut upon the ordinary blanks of commerce in the usual way with a mechanical duplicating-machine.

When the commercial water solution of gelatin is employed in the formation of the matrix from the master-record, it is necessary in making the duplicate record therefrom to employ a material which will not affect the gelatin—such, for instance, as an alcohol and ether solution of celluloid or an easily-fusible composition of wax and rosin. If the gelatin is rendered waterproof by the addition of bichromate of potash and exposure to the sun, many more materials—such as water-glass, plaster-of-paris, starch, and other material having water in their composition—become available for use in forming the duplicate records and the scope of the invention thereby greatly enlarged.

My invention consists, further, of the improved film-matrix and the improved film-record formed from solutions of suitable materials, as hereinafter more particularly pointed out.

My invention consists of further features of improvement ancillary to the above-mentioned main features, and in order that my invention may be fully understood I will first describe the same with reference to the accompanying drawings and afterward point out the novelty with more particularity in the annexed claims.

In said drawings, Figure 1 is a longitudinal sectional view of a cylindrical master-record formed in the usual way upon a sound-recording machine. Fig. 2 is a similar view showing the master-record with its attached gelatin-film matrix formed by dipping the master-record in a fluid gelatin. Fig. 3 is a detail sectional view of the gelatin-film matrix detached from the master-record by breaking or otherwise removing the master-record. Fig. 4 is a similar view representing the gelatin-film matrix with the attached celluloid-film record formed by dipping the matrix in a solution of celluloid or otherwise forming the celluloid or other material therein. Fig. 5 is a detail view of a separated celluloid-film record. Fig. 6 is a similar view representing the film-record having a suitable backing fitted within it, the backing being shown as made of a suitable material molded into the film-record.

The original or master record 1, formed in the usual way upon a sound-recording machine, is dipped in a solution of gelatin to form a gelatin-film matrix 2 upon its record-surface. The record may be dipped a sufficient number of times to form a film of the desired thickness, the coating being allowed to cool and partly evaporate and dry between the dippings. The master-record, with attached film-matrix 2, is then put aside to dry for about twelve hours, when the film of gelatin will assume a hard horny aspect. The film-coated master-record is then taken in the hand and with a steel bar or other suitable instrument is given two or three sharp blows to crack the master-record within the film-matrix, when the pieces of the master-record will readily fall out, leaving a film-matrix with a perfect clear-cut negative record upon its inner surface. The film-matrix 2, formed as just described, is then taken and dipped in a solution of suitable material, such as celluloid, it being dipped a sufficient number of times to produce a film-record 3 of the proper thickness. This coated matrix is then allowed to dry, and the celluloid-film record 3 will be readily detachable from the matrix. In making the solution of celluloid for producing the film-record I may add a proper quantity of a suitable material to cause the solution to contract in drying, so as to cause the film to be separated from the matrix and facilitate its removal.

In place of dipping the film-matrix in a solution of celluloid I may take a sheet of celluloid and coat its surface with a celluloid solution and impress the surface coated with the semifluid material against the matrix-face of the film-matrix, the jointed ends of the celluloid sheet being cemented by the celluloid solution and the ridge or uneven portion of the joint pressed out against the matrix. The matrix, with celluloid impressed upon, it is then allowed to dry, and the evaporation or drying out of the alcohol and ether of the celluloid solution forms a vacuum between the celluloid sheet and matrix and causes the celluloid to closely adhere to the matrix and faithfully reproduce the record thereof. When the celluloid and its film-coated surface have become perfectly dry, so as to form practically an integral cylindrical record within the matrix-cylinder, I separate the celluloid record from the matrix by bending the celluloid record inwardly away from the matrix at different points and then partially collapsing the record to allow it to be withdrawn from the matrix. This bending and collapsing of the celluloid record within the matrix does not injure the record, because of its elastic nature.

In place of the use of celluloid for the record I may employ a mixture of beeswax and rosin. The ordinary record of commerce is made up of stearic acid, aluminium or a suitable salt of aluminium, and caustic potash fused together into an intimate mass, which is molded into the desired shape. This material has a very high melting-point and could not be molded in a matrix of gelatin formed according to my process, as the heat of the material in a fluid state would melt the record upon the gelatin matrix. I have discovered that a mixture of rosin and beeswax can be kept in fluid state at a very low temperature—lower, in fact, than the beeswax alone—and as the rosin tempers the wax and removes its objectionable viscous quality I am able to form a very satisfactory record of this material. The mixture of rosin and beeswax in about equal proportions is flowed into the gelatin-film matrix or the matrix is dipped into the fluid mixture and the mixture forms upon the matrix, as in the use of the semifluid solution of celluloid. The beeswax-and-rosin record is allowed to dry and harden, and in

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drying it contracts and separates from the film-matrix and can readily be removed.

If desired, a suitable paper backing may be coated with a film of celluloid or other suitable record-forming solution and the semifluid film-surface impressed against the matrix to form the phonographic record. The paper backing may be in any preferred shape to suit the machine for which the record is prepared.

Any other material suitable for the body of the record may be covered with the impressible fluid or semifluid material and a record impressed upon it, as above described, without departing from the spirit of my invention.

One disadvantage in the use of the ordinary commercial solution of gelatin in forming the matrices is that the gelatin is soluble in water, and therefore materials having water in their composition cannot be employed to form the records. To avoid this objection, I propose to render the gelatin solution waterproof by mixing with the solution a suitable quantity of bichromate of potash and then exposing the mixture to the sun. As is well known, this will produce a waterproof gelatin solution. With the matrix formed of this water proof gelatin it is possible to use many materials, such as silicate of soda, plaster-of-paris, starch, and other materials which contain water. The waterproofing of the gelatin greatly broadens the scope of my invention, as many materials become available for making the records which could not otherwise be used.

The record formed as above described may or may not be of sufficient strength in itself to withstand the wear and tear to which a record is subjected. If the record is a mere film, as when made of celluloid solution, it is necessary to strengthen it by providing it with a suitable backing. This backing may be a properly-shaped paper form or it may be plaster-of-paris or other material 4, molded into the film-record around a suitable mandrel or former. In Fig. 6 I have shown the film-record upon a backing 4 of molded material, such as plaster-of-paris.

It will of course be understood that I do not limit myself to any particular shape of record, my invention being equally applicable for making a cylindrical or a flat record.

In using the term "dipping" I mean to cover flowing the fluid coating material upon the matrix or record surface, immersing the matrix or master-record in the coating material, or otherwise covering the matrix or record surface with the impressible fluid or semifluid material.

As above stated, the record may be made from the film-matrix by electroplating in the usual well-known way without departing from the spirit of my invention.

I would have it understood that those claims employing such expressions as "bringing a solution of a suitable material into contact with the matrix (or record) surface" are intended to cover the use of a suitable material in any impressible state, whether fluid or semifluid and whether the material is applied direct to the matrix or record or is first applied to a backing or body material and afterward brought into contact with the matrix or record.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The herein-described process of producing sound-records, which consists in forming a matrix of the desired record, then coating the matrix with a solution of a suitable material to form thereon a film-record, and finally separating the film-record from the matrix, as set forth.

2. The herein-described process of producing sound-records, which consists in forming a matrix of the desired record, then dipping the matrix in a solution of a suitable material, then allowing the coated matrix to dry to form upon the matrix a film-record, and finally separating the film-record from the matrix, substantially as set forth.

3. The herein-described process of forming matrices of sound-records, which consists in coating a master-record with a solution of a suitable material and allowing it to dry thereon to form upon the master-record a film-matrix, and then removing the master-record, as set forth.

4. The herein-described process of forming matrices of sound-records, which consists in dipping a master-record in a solution of a suitable material, allowing the coated master-record to dry, and finally removing the master-record from the film-matrix, substantially as set forth.

5. The herein-described process of duplicating sound-records which consists in coating a master-record with a solution of a suitable material and allowing it to dry to form upon the master-record a film-matrix, then removing the master-record from the film-matrix, and finally forming a suitable material in the film-matrix and removing the matrix from the duplicate record thereby produced, substantially as set forth.

6. The herein-described process of duplicating sound-records, which consists in dipping or flowing a suitable coating material upon a master-record, allowing the same to dry and harden upon the record, then removing the master-record from the matrix thus formed, and finally forming a duplicate record in or upon the matrix, substantially as set forth.

7. The herein-described process of duplicating sound-records, which consists in dipping a master-record in a solution of a suitable material, thereby forming a film-matrix upon the master-record, next removing the master-record from the film-matrix, then dipping the film-matrix in a solution of suitable material

to form a film-record thereon, then separating the film-record from the matrix; substantially as set forth.

8. The herein-described process of duplicating sound-records, which consists in dipping a master-record in a solution of gelatin and allowing it to dry, thereby forming a film-matrix upon the master-record, next breaking or otherwise removing the master-record from the film-matrix, then dipping the film-matrix in a solution of celluloid and allowing it to dry, forming a film-record upon the matrix, then separating the film-record of celluloid from the matrix, substantially as set forth.

9. The herein-described process of duplicating sound-records, which consists in dipping a master-record in a solution of gelatin and allowing it to dry, thereby forming a film-matrix upon the master-record, next breaking or otherwise removing the master-record from the film-matrix, then dipping the film-matrix in a solution of celluloid and allowing it to dry, forming a film-record upon the matrix, then removing the film-record of celluloid from the matrix, and finally mounting it upon a suitable backing, substantially as set forth.

10. The herein-described process of duplicating sound-records which consists in dipping a master-record in a waterproof solution of gelatin, then removing the master-record from the film-matrix formed upon the same and finally forming a duplicate record in the waterproof gelatin matrix and removing the record thus formed from the matrix, substantially as set forth.

11. As an article of manufacture, a sound-record consisting of irregularities corresponding to sound-waves, the same being molded upon a horny surface formed by the evaporation of a solution upon a suitable matrix-surface, substantially as described.

FRANK L. CAPPS.

Witnesses:
A. B. C. SALMON,
N. CARTER.

No. 667,202. Patented Feb. 5, 1901.

# T. A. EDISON.

## APPARATUS FOR DUPLICATING PHONOGRAPH RECORDS.

(Application filed May 8, 1900.)

(No Model.)

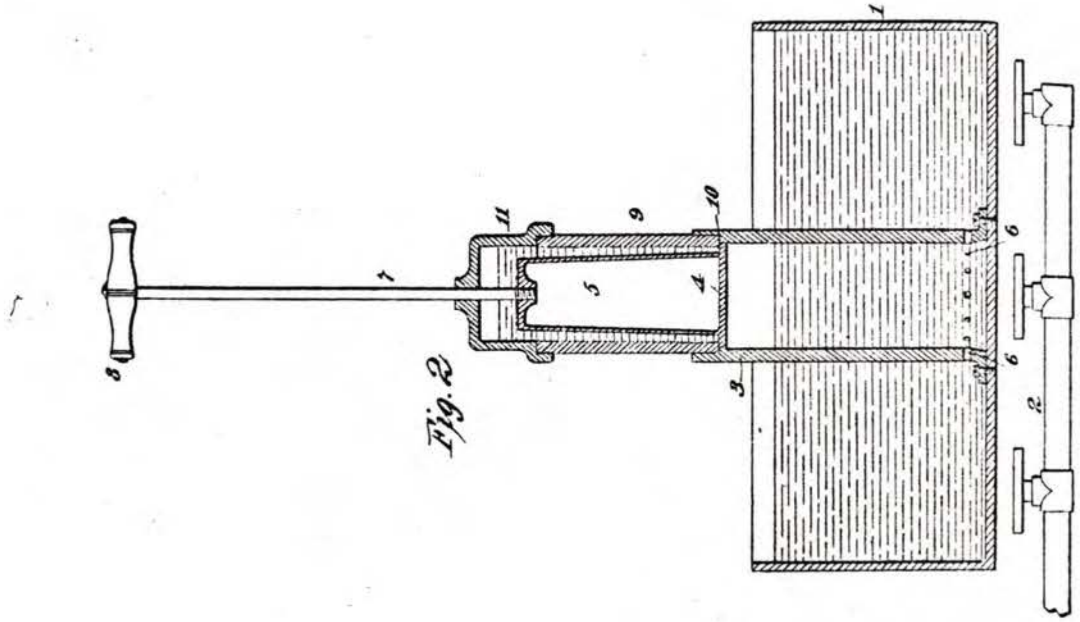


Fig. 2

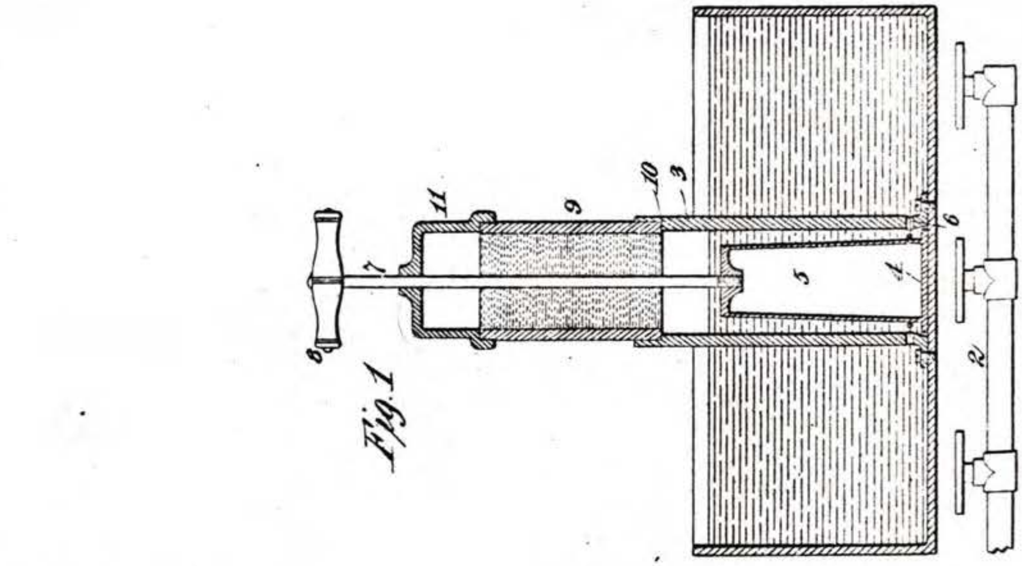


Fig. 1

**Witnesses:**

Jas. F. Coleman

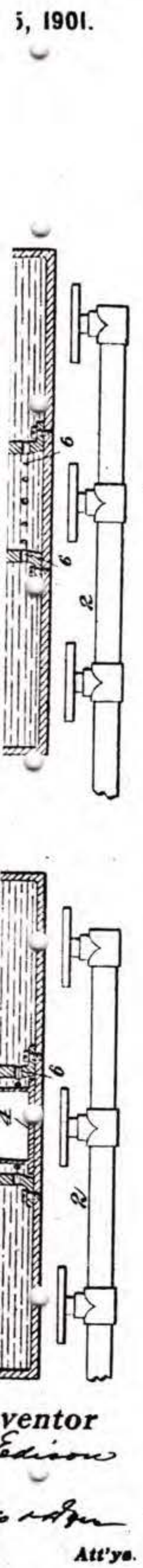
Jno. R. Taylor

**Inventor**

Thomas A. Edison

by Dyer Edmonds & Dyer

Att'ys



# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## APPARATUS FOR DUPLICATING PHONOGRAPH-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 667,202, dated February 5, 1901.

Application filed May 8, 1900. Serial No. 15,875. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Duplicating Phonograph-Records, (Case No. 1,037,) of which the following is a description.

In my companion application filed on even date herewith (Edison, No. 1,036) I describe an improved process for duplicating phonograph-records, and particularly for the duplicating of cylindrical phonographic records, consisting in forming a mold carrying on its bore the record in negative, in introducing within the mold around a core a molten material the surface of which becomes chilled by contact with the mold, in then permitting the duplicate so formed to contract, in then removing the contracted duplicate and the core from the mold by a direct longitudinal movement, in then separating the core from the duplicate before the latter has contracted sufficiently to prevent such separation, and in finally dressing the ends of the duplicate and in reaming out its interior.

My present application relates to an improved apparatus for the convenient, economical, and effective carrying out of this process; and my object is to provide an apparatus wherein a process of duplicating phonograph-records from a continuous mold can be effectively followed.

In order that my invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a sectional view of a suitable apparatus for the purpose, illustrating the plunger and piston in their lowermost positions; and Fig. 2, a similar view showing the same parts in their elevated positions.

In both the above views corresponding parts are represented by the same numerals of reference.

The apparatus illustrated in the figures is designed for the duplicating of cylindrical phonographic records, and it will be so described; but the applicability of my improved apparatus for the duplication of other varieties of records will be apparent to those skilled in the art.

In the drawings, 1 represents a suitable jar or tank of the proper dimensions and made of any desired material. Within the jar or tank 1 I place the material of which the duplicate records are to be formed and which may be maintained in a molten condition by the application of heat in any way—as, for example, by a gas-tube 2, supplying a number of jets, as shown. The proper level of the molten material is indicated, and this level should be approximately maintained by the addition of fresh material from time to time within the tank, as the liquid material may be withdrawn during the operation. The material in the tank 1 and of which the duplicate records are to be formed may be of any suitable character; but, preferably, it is a metallic soap or a combination of several soaps to which has been added a material not affected by water, such as ceresin, whereby the resulting duplicates will be protected from the effects of atmospheric moisture. Mounted within the tank and secured to its bottom is an open-ended cylinder 3, in which works a piston 4. A tapered core 5 is connected to or formed integrally with the piston 4, and said core is preferably hollow, so as to present a thin wall to the material, whereby the core will very quickly reach the temperature of the molten material when it is immersed therein. A number of openings 6 are formed in the cylinder 3, near the bottom thereof, below which openings the piston 4 passes in reaching its downward position, as shown in Fig. 1, whereby the liquid material may flow through said openings into the cylinder above the piston. Connected to the core 5 is a plunger 7, having an operating-handle 8. The connection between the core and plunger is such as will permit a separation of these parts, ordinary screw-threads being shown. 9 represents a mold which rests within a shoulder 10, formed at the top of the cylinder, and which mold carries on its bore the representation in negative or relief of a phonograph-record which it is desired to duplicate. This mold is preferably obtained by the process described in my application for Letters Patent filed March 5, 1898, Serial No. 672,650, by first depositing upon the original record a suitable metal in the form of an infinitesimally thin film by a process of vacuous deposit, by then electroplating or otherwise securing upon the film so obtained a sufficiently thick layer of the same or different metal, and by then properly backing up the metal so deposited or otherwise applied to the vacuous film either before or after the separation of the original record from the inclosing coating of metal either by contracting the record or by melting it out or in any other suitable way. The advantage of making a matrix or mold by first depositing upon an original phonograph-record a metal by a process of vacuous deposit is that an absolutely accurate copy in negative of such record will be produced, irrespective of the fineness thereof. The mold 9 is preferably made of sufficient mass or thickness as to effectively chill the molten material when the latter is introduced therein, as I shall explain. Carried by the upper part of the mold is an inclosing cap 11, which may be secured onto the mold and which forms a bearing for the plunger 7.

In making duplicate records with my improved apparatus I prefer to proceed substantially as follows: Molten material being placed within the tank or jar 1 is maintained in its liquid or fluid condition by the application of heat. The mold 9 being exposed to the atmospheric temperature is relatively cold. The plunger 7 is first depressed, so as to force the piston 4 downward within the cylinder, ejecting the liquid material from beneath it, which material passes out through the openings 6. The bore of the cylinder 3 may, as shown, be slightly enlarged below the openings 6, so as to permit the piston 4 to pass beneath the same. As soon as the piston 4 passes below the openings 6 the molten or fluid material enters the cylinder above the piston, so as to fill the cylinder to the level of the liquid in the tank or jar. Owing to the thin wall of the core 5 the latter will almost immediately reach the temperature of the molten material, so that said core will not chill the latter. If a solid core is used, it will require to be immersed within or below the surface of the liquid material for a longer time to enable its temperature to reach that of the molten mass; but with this exception the process will be equally operative with a solid core as with a hollow core.

Assuming the hollow core to be used and that its temperature reaches that of the molten material almost immediately, the plunger 7 will be elevated so as to carry the charge of molten material above the piston into the mold, as shown in Fig. 2, a greater or less excess of material passing above the mold into the cap 11. By employing the cap 11 it will be obvious that the level of the liquid material in the tank or jar may be varied considerably without affecting the operation. The liquid molten material entering the mold 9 will engage all portions of the record formed on the bore thereof, and the materially lower temperature of the mold will result in the almost instantaneous chilling of the surface of the molten material therein. In order to facilitate this surface-chilling of the liquid molten material entering the mold, the latter may be actually cooled by artificial means below atmospheric temperature—as, for instance, by the circulation of cold water through a water-jacket surrounding the mold or by a blast of cold air equably directed to all portions of the mold. The chilling of the surface of the molten material in the mold results in the setting of the positive impression thus secured from the negative record. The chilling of the molten material in the mold progresses toward the center and any contraction in bulk will be compensated by the surplus material within the cap 11. As soon as the material within the mold has been chilled, throughout the entire thickness thereof, the material, with the piston, core, cap, and plunger, is removed from the cylinder, and the material is allowed to cool by exposure to a cold atmosphere or by an air-blast until the solidified material has contracted away from the bore of the mold, so as to permit it to be removed therefrom by forcing the plunger downward. The plunger is then removed from the core and the latter is extracted from the cast material, carrying the positive record on its periphery, before the material is contracted sufficiently upon the core as to prevent this separation. Since the conductivity of heat from the material is effected slowly, the outer surface of the molded duplicate becomes hard and set, while the inner portion thereof next to the core is still in a relatively plastic condition, so that this separation of the core can with ordinary care be readily effected. The resulting duplicates thus secured after reaching the normal temperature are properly dressed at the ends and are reamed internally to the proper size, being then ready for use. With records made in this way the contraction of the material radially to separate it from the mold is accompanied by a considerable longitudinal contraction following the instant when the surface is first set by the chilling effect of the mold and progressing until the material reaches the normal temperature. For this reason it is necessary that the original record from which the matrix is made be formed on a phonograph or allied talking-machine having a fewer number of threads on its feed-screw than the instrument on which the duplicates are finally used in order that when the contraction has progressed to its finality the pitch of the record-thread on the duplicate will correspond to the pitch of the feed-screw of the reproducing-machine, or approximately to that pitch, it being possible with modern reproducing apparatus to effect a satisfactory reproduction from a record, even when the pitch thereof differs slightly from that of the feed-screw of the machine. The pitch of the feed-screw of the machine on

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which the original record is made will differ from the pitch of the feed-screw of the machine on which the resulting duplicates are to be used to an extent depending upon the coefficient of contraction of the material used and will be determined by experiment with the material employed. It will be of course understood that after the mold has been removed from the cylinder and the separation of the cast duplicate is being effected therefrom a new mold and its accompanying parts may be inserted in place upon the cylinder and the operations repeatedly carried on therewith.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. An apparatus for duplicating phonograph-records, comprising in combination a mold carrying a record in negative on its bore, a core movable into and out of the mold, and means for causing a supply of molten material to enter the mold simultaneously with the introduction therein of the core, substantially as set forth.

2. An apparatus for duplicating phonograph-records, comprising in combination a mold carrying a record in negative on its bore, a cylinder supporting said mold and supplied with molten material, a core movable in said cylinder and mold, and a piston movable with the core for introducing a charge of molten material into the mold simultaneously with the introduction therein of said core, substantially as set forth.

3. An apparatus for duplicating phonograph-records, comprising in combination a mold carrying a record in negative on its bore, a cylinder supporting said mold and supplied with molten material, a hollow core movable in said cylinder and mold, and a piston movable with the core for introducing a charge of molten material into the mold simultaneously with the introduction therein of said core, substantially as set forth.

4. In an apparatus for duplicating phonograph-records, the combination of a mold carrying a record in negative on its bore, a cylinder removably supporting said mold and supplied with molten material, a core movable in said cylinder and mold, and means for introducing molten material into the mold simultaneously with the introduction of the core therein, substantially as set forth.

5. An apparatus for duplicating phonograph-records, comprising in combination a receptacle containing molten material, a cylinder in said receptacle, a mold carried by said cylinder, a core movable in the cylinder and mold, and a piston working in said cylinder simultaneously with said core, substantially as set forth.

6. An apparatus for duplicating phonograph-records, comprising in combination a receptacle for containing a molten material, a cylinder in said receptacle, a mold removably carried by the cylinder and having a record in negative on its bore, a core movable in the cylinder and mold, a piston working in said cylinder and connected to the mold, and a plunger for operating said core, substantially as set forth.

7. An apparatus for duplicating phonograph-records, comprising in combination a receptacle for containing a molten material, a cylinder in said receptacle, a mold removably carried by the cylinder and having a record in negative on its bore, a core movable in the cylinder and mold, a piston working in said cylinder and connected to the mold, and a plunger removably connected with the core for operating the latter, substantially as set forth.

8. In an apparatus for duplicating phonograph-records, the combination of a receptacle or tank for containing the molten material, a cylinder therein, a mold movably carried by the cylinder and having a record in negative on its bore, a core working in the cylinder and mold, a piston connected to the core, and a cap secured over the upper side of the mold, substantially as set forth.

9. In an apparatus for duplicating phonograph-records, the combination of a receptacle or tank for containing the molten material, a cylinder therein, a mold movably carried by the cylinder and having a record in negative on its bore, a core working in the cylinder and mold, a piston connected to the core, and a cap removably secured over the upper end of the mold, substantially as set forth.

10. In an apparatus for duplicating phonograph-records, the combination of a receptacle or tank for containing the molten material, a cylinder therein, a mold movably carried by the cylinder and having a record in negative on its bore, a core working in the cylinder and mold, a piston connected to the core, a cap secured over the upper end of the mold, a bearing in said cap, and a plunger working in said bearing and connected to the core, substantially as set forth.

This specification signed and witnessed this 30th day of April, 1900.

THOS. A. EDISON.

Witnesses:
J. F. Randolph,
Frank L. Dyer.

No. 667,662. Patented Feb. 5, 1901.

## T. A. EDISON.

## PROCESS OF DUPLICATING PHONOGRAPH RECORDS.

(Application filed May 8, 1900.)

(No Model.)

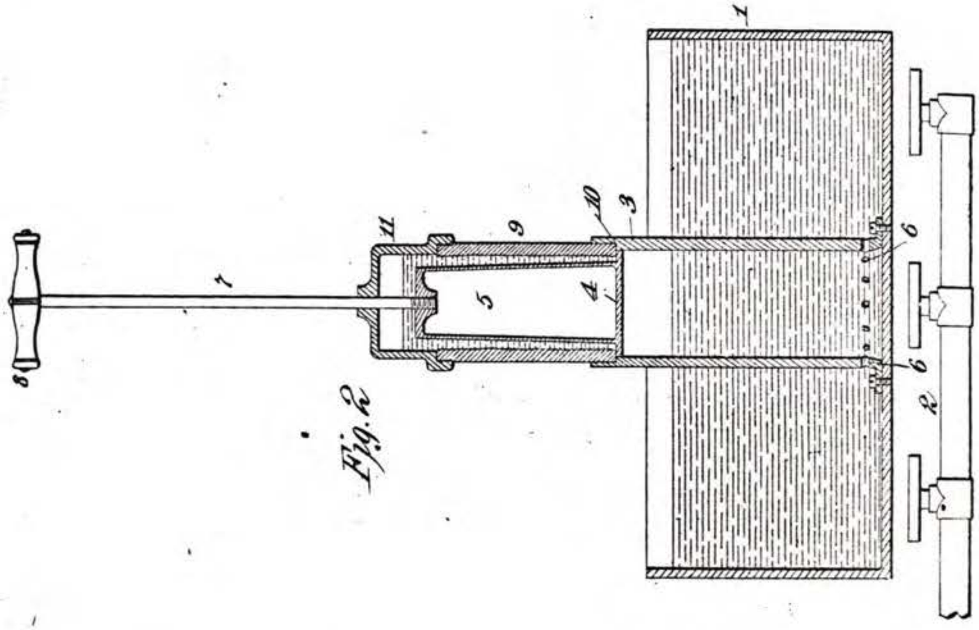


Fig. 2

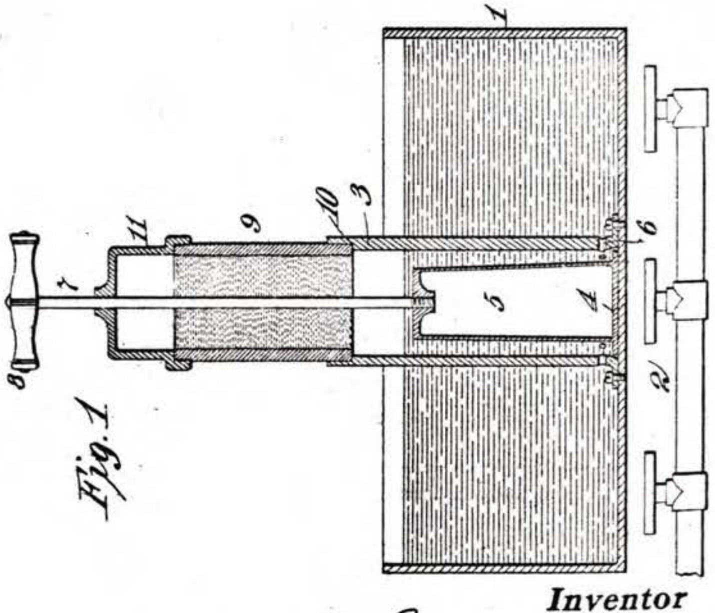


Fig. 1

Witnesses:

Jas. F. Coleman

Jno. R. Taylor

Inventor

Thomas A. Edison

by Dyer Edmonds & Dyer

Att'ys.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PROCESS OF DUPLICATING PHONOGRAPH-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 667,662, dated February 5, 1901.

Application filed May 8, 1900. Serial No. 15,874. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, county of Essex, and State of New Jersey, have invented a certain new and useful Improved Process of Duplicating Phonograph-Records, (No. 1,036,) of which the following is a specification.

My invention relates to an improved process for duplicating phonograph-records, and the process is of the character covered by my Patent No. 484,582, of October 18, 1892, wherein a matrix of an original record is employed as a mold for the making of the duplicates. In the specific process described in my previous patent the matrix secured from the original record is divided longitudinally, so as to form a sectional mold in which are cast the desired duplicates. My present invention is designed specifically as an improvement on said process, and my object is to provide a process wherein the production of the duplicate records will be facilitated and wherein the character of the resulting duplicates will be improved, since the mold used is continuous on its bore.

My present process depends upon the fact that after a molten metallic soap or a mixture of soaps or other suitable material has been introduced within a mold carrying the representation of a phonographic record in relief on its bore and allowed to set a sufficient contraction of the resulting duplicate can be secured as to permit of a longitudinal separation of the duplicate from the mold, whereby a continuous mold can be employed for the carrying on of the process.

In order that my invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a sectional view of a suitable apparatus for the purpose, illustrating the plunger and piston in their lowermost position; and Fig. 2, a similar view showing the same parts in their elevated positions.

In both the above views corresponding parts are represented by the same numerals of reference.

The apparatus illustrated in the figures is designed for the duplicating of cylindrical phonographic records, and it will be so described; but the applicability of my process for the duplication of other varieties of records will be apparent to those skilled in the art.

In the drawings, 1 represents a suitable jar or tank of the proper dimensions and made of any desired material. Within the jar or tank 1 I place the material of which the duplicate records are to be formed and which may be maintained in a molten condition by the application of heat in any way—as, for example, by a gas-tube 2, supplying a number of jets, as shown. The proper level of the molten material is indicated, and this level should be approximately maintained by the addition of fresh material from time to time within the tank as the liquid material may be withdrawn during the operation. The material in the tank 1 and of which the duplicate records are to be formed may be of any suitable character; but preferably it is a metallic soap or a combination of several soaps to which has been added a material not affected by water, such as ceresin, whereby the resulting duplicates will be protected from the effects of atmospheric moisture. Mounted within the tank and secured to its bottom is an open-ended cylinder 3, in which works a piston 4. A tapered core 5 is connected to or formed integrally with the piston 4, and said core is preferably hollow, so as to present a thin wall to the material, whereby the core will very quickly reach the temperature of the molten material when it is immersed therein. A number of openings 6 are formed in the cylinder 3, near the bottom thereof, below which openings the piston 4 passes in reaching its downward position, as shown in Fig. 1, whereby the liquid material may flow through said openings into the cylinder above the piston. Connected to the core 5 is a plunger 7, having an operating-handle 8. The connection between the core and plunger is such as will permit a separation of these parts, ordinary screw-threads being shown.

9 represents a mold which rests within a shoulder 10, formed at the top of the cylinder, and which mold carries on its bore the representation in negative or relief of a phonograph-record which it is desired to duplicate. This mold is preferably obtained by

the process described in my application for Letters Patent filed March 5, 1898, Serial No. 672,650, by first depositing upon the original record a suitable metal in the form of an infinitesimally-thin film by a process of vacuous deposit, by then electroplating or otherwise securing upon the film so obtained a sufficiently thick layer of the same or different metal, and by then properly backing up the metal so deposited or otherwise applied to the vacuous film either before or after the separation of the original record from the inclosing coating of metal either by contracting the record or by melting it out or in any other suitable way. The advantage of making a matrix or mold by first depositing upon an original phonograph-record a metal by a process of vacuous deposit is that an absolutely accurate copy in negative of such record will be produced irrespective of the fineness thereof. The mold 9 is preferably made of sufficient mass or thickness as to effectively chill the molten material when the latter is introduced therein, as I shall explain. Carried by the upper part of the mold is an inclosing cap 11, which may be secured onto the mold and which forms a bearing for the plunger 7.

In carrying out my improved process with an apparatus of this type I prefer to proceed substantially as follows: Molten material being placed within the tank or jar 1 is maintained in its liquid or fluid condition by the application of heat. The mold 9, being exposed to the atmospheric temperature, is relatively cold. The plunger 7 is first depressed, so as to force the piston 4 downward within the cylinder, ejecting the liquid material from beneath it, which material passes out through the openings 6. The bore of the cylinder 3 may, as shown, be slightly enlarged below the openings 6, so as to permit the piston 4 to pass beneath the same. As soon as the piston 4 passes below the openings 6 the molten or fluid material enters the cylinder above the piston, so as to fill the cylinder to the level of the liquid in the tank or jar. Owing to the thin wall of the core 5 the latter will almost immediately reach the temperature of the molten material, so that said core will not chill the latter. If a solid core is used, it will require to be immersed within or below the surface of the liquid material for a longer time to enable its temperature to reach that of the molten mass; but with this exception the process will be equally operative with a solid core as with a hollow core.

Assuming the hollow core to be used and that its temperature reaches that of the molten material almost immediately, the plunger 7 will be elevated, so as to carry the charge of molten material above the piston into the mold, as shown in Fig. 2, a greater or less excess of material passing above the mold into the cap 11. By employing the cap 11 it will be obvious that the level of the liquid material in the tank or jar may be varied considerably without affecting the operation. The liquid molten material entering the mold will engage all portions of the record formed on the bore thereof, and the materially lower temperature of the mold will result in the almost instantaneous chilling of the surface of the molten material therein. In order to facilitate this surface-chilling of the liquid molten material entering the mold, the latter may be actually cooled by artificial means below atmospheric temperature—as, for instance, by the circulation of cold water through a water-jacket surrounding the mold or by a blast of cold air equably directed to all portions of the mold. The chilling of the surface of the molten material in the mold results in the setting of the positive impression thus secured from the negative record. The chilling of the molten material in the mold progresses toward the center, and any contraction in bulk will be compensated by the surplus material within the cap 11. As soon as the material within the mold has been chilled throughout the entire thickness thereof the material with the piston, core, cap, and plunger are removed from the cylinder, and the material is allowed to cool by exposure to a cold atmosphere or by an air-blast until the solidified material has contracted away from the bore of the mold, so as to permit it to be removed therefrom by forcing the plunger downward. The plunger is then removed from the core, and the latter is extracted from the cast duplicate, carrying the positive record on its periphery before the material has contracted sufficiently upon the core as to prevent this separation. Since the conductivity of heat from the material is effected slowly, the outer surface of the molded duplicate becomes hard and set, while the inner portion thereof next to the core is still in a relatively plastic condition, so that this separation of the core can with ordinary care be readily effected. The resulting duplicates thus secured after reaching the normal temperature are properly dressed at the ends and are reamed internally to the proper size, being then ready for use.

With records made by my process the contraction of the material radially to separate it from the mold is accompanied by a considerable longitudinal contraction following the instant when the surface is first set by the chilling effect of the mold and progressing until the material reaches the normal temperature, such shrinkage being approximately one per cent. with ordinary blanks. For this reason it is desirable that the original record from which the matrix is made is formed on a phonograph or allied talking-machine having a fewer number of threads on its feed-screw than the instrument on which the duplicates are finally used, in order that when the contraction has progressed to its finality the pitch of the record-thread on the duplicate will correspond to the pitch of the feed-screw of the reproducing-machine or approximately to that pitch, it being possible with modern reproducing apparatus to effect a satisfactory reproduction from a record, even when the pitch thereof differs slightly from that of the feed-screw of the machine. The pitch of the feed-screw of the machine on which the original record is made will differ from the pitch of the feed-screw of the machine on which the resulting duplicates are to be used to an extent depending upon the coefficient of contraction of the material used and will be determined by experiment with the material employed. It will be of course understood that after the mold has been removed from the cylinder and the separation of the cast duplicate is being effected therefrom a new mold and its accompanying parts may be inserted in place upon the cylinder, and the operations repeatedly carried on therewith.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. The process of duplicating cylindrical phonographic records, which consists in first making an original record with a spiral record-groove of greater pitch than that desired on the duplicate to be produced, then in making a hollow cylindrical matrix or mold from said original record, carrying the record in negative on its bore, and in finally making duplicate records from the matrix or mold by introducing therein and engaging therewith material maintained in an abnormally high temperature, whereby the cooling of such duplicate will contract the pitch of the record-groove, as and for the purposes set forth.

2. The process of duplicating phonographic records, which consists in securing a mold containing the record in negative on its bore, in introducing a molten material in the mold to receive a surface impression from such record, in allowing the molten material to set, in contracting the set material, and in separating the contracted molded material by a longitudinal movement, substantially as set forth.

3. The process of duplicating phonographic records, which consists in securing a mold having a record in relief in negative on its bore, in introducing a molten material in the mold around a core, in allowing the molten material to set, in contracting the set material, in removing the contracted material and the core from the mold, and in separating the core from the molded material, substantially as set forth.

4. The process of duplicating cylindrical phonograph-records, which consists in forming a cylindrical mold with a record in negative on its bore, in introducing a molten material in the mold to form a cylindrical duplicate, in allowing the duplicate to set, in contracting the duplicate, and in removing the contracted duplicate by a direct longitudinal movement, substantially as set forth.

5. The process of duplicating cylindrical phonograph-records, which consists in forming a cylindrical mold having the record in negative on its bore, in introducing molten material in the mold around a core, whereby a hollow cylindrical duplicate will be formed, in allowing the molten material to set, in contracting the molten material, and in withdrawing the contracted material from the mold by a direct longitudinal movement, substantially as set forth.

6. The process of duplicating cylindrical phonograph-records, which consists in forming a cylindrical mold carrying the record in negative on its bore, in introducing a molten material in the mold around a core, in allowing the material to set, in contracting the material, in withdrawing the contracted material and core from the mold, and in separating the core from the resulting duplicate, substantially as set forth.

7. The process of duplicating cylindrical phonograph-records, which consists in making a cylindrical mold carrying a record in negative on its bore, and of sufficient mass to produce a chilling effect on molten material introduced therein, then in introducing within the mold a molten material, the surface of which becomes chilled by contact with the mold, then in contracting the duplicate so formed, and finally, separating the duplicate from the mold by a direct longitudinal movement, substantially as set forth.

8. The process of duplicating cylindrical phonograph-records, which consists in securing a mold carrying a record in negative on its bore, and of sufficient mass to produce a chilling effect on molten material introduced therein, then in introducing within the mold around a core a molten material, the surface of which is chilled by contact with the mold, then in contracting the material, then in removing the contracted material and core from the mold, and in finally separating the core from the material, substantially as set forth.

9. The process of duplicating cylindrical phonograph-records, which consists in maintaining in a molten condition a mass of material from which the duplicates are to be made, in sustaining a mold over the mass of molten material, said mold carrying on its bore a record in negative, in successively elevating a part of the mass of molten material into the mold, in allowing such molten material within the mold to set, in contracting the set material, and in withdrawing the resulting duplicate from the mold by a direct longitudinal movement, substantially as set forth.

This specification signed and witnessed this 30th day of April, 1900.

THOS. A. EDISON.

Witnesses:

J. F. RANDOLPH,
FRANK L. DYER.

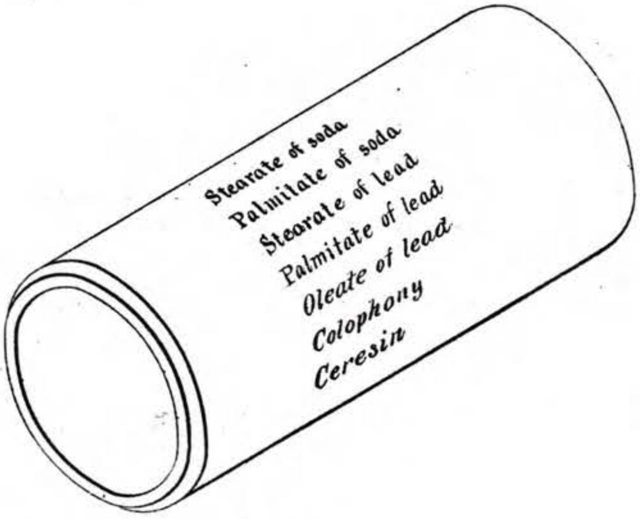
No. 676,111. Patented June 11, 1901.

## J. W. AYLSWORTH.

## PHONOGRAPHIC RECORD BLANK.

(Application filed Aug. 11, 1900.)

(No Model.)



**Witnesses:**

Jas. F. Coleman

Archibald G. Reese

**Inventor**

Jonas Walter Aylsworth

by Dyer Edmonds & Dyer

Att'ys.

# UNITED STATES PATENT OFFICE.

JONAS WALTER AYLSWORTH, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO THE NATIONAL PHONOGRAPH COMPANY, OF ORANGE, NEW JERSEY.

## PHONOGRAPHIC RECORD-BLANK.

**SPECIFICATION forming part of Letters Patent No. 676,111, dated June 11, 1901.**

Application filed August 11, 1900. Serial No. 26,643. (No specimens.)

*To all whom it may concern:*

Be it known that I, JONAS WALTER AYLSWORTH, a citizen of the United States, residing at East Oarnge, in the County of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographic Record-Blanks, of which the following is a description.

My invention relates to improvements in compositions for phonographic record-blanks; and my object is to secure a composition by which blanks of superior quality to those now in use can be produced, while the cost of such blanks will be materially reduced.

In the accompanying drawing I illustrate a perspective view of a phonograph-blank, indicating thereon the preferred combination of ingredients therefor.

My improved composition for phonographic record-blanks consists of an alkaline soap of higher fatty acids of the acetic series—as, for example, a stearate or palmitate, or both, of an alkali, such as soda—a lead soap of higher fatty acids of the acetic series—as, for example, a stearate or palmitate, or both, of lead—oleate of lead, a resinous substance—such as colophony, gum-copal, gum-kauri, &c.—and preferably a hydrocarbon—such as paraffin, ozocerite, ceresin, &c.—as indicated in the drawing. The stearic acid of commerce, from which stearate of lead and stearate of soda are made, is composed of a mixture of stearic acid and palmitic acid, so that the products secured therefrom comprise a mixture of stearate and palmitate of lead or soda, as the case may be. For cheapness of manufacture, therefore, I prefer to manufacture stearate and palmitate of lead or soda from the ordinary stearic acid of commerce, and therefore the most economical composition of my present invention is one utilizing both stearate and palmitate of lead and soda. It is to be understood, however, that a composition is within the scope of my present invention if it utilizes either stearate or palmitate of lead or of soda or any desired combination of such products.

Proportions with which I have secured excellent results are the following: ninety-six parts, by weight, of stearate and palmitate of soda, containing about 6.9 parts of sodium oxid, ($Na_2O$;) seventy-three parts, by weight, of stearate and palmitate of lead, containing about twenty-one parts of lead oxid, (PbO;) nine parts, by weight, of oleate of lead, containing about 2.5 parts lead oxid; ten parts, by weight, colophony; two parts, by weight, ceresin. These proportions may be varied considerably without departing from the spirit of my invention. For instance, the ceresin may be omitted entirely if it is desired to produce a harder composition, and the proportion of oleate of lead may be reduced to attain the same end.

The resulting blanks are absolutely non-crystalline in character, hard, perfectly smooth, and more or less transparent.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. A composition for phonograph record-blanks, comprising an alkaline soap of higher fatty acids of the acetic series, a lead soap of higher fatty acids of the acetic series, oleate of lead and an acid resin, substantially as set forth.

2. A composition for phonograph record-blanks, comprising soda soap of higher fatty acids of the acetic series, lead soap of higher fatty acids of the acetic series, oleate of lead and an acid resin, substantially as set forth.

3. A composition for phonograph record-blanks, comprising an alkaline soap of higher fatty acids of the acetic series, a lead soap of higher fatty acids of the acetic series, oleate of lead, an acid resin, and a hydrocarbon, substantially as set forth.

4. A composition for phonograph record-blanks, comprising soda soap of higher fatty acids of the acetic series, lead soap of higher fatty acids of the acetic series, oleate of lead, an acid resin, and a hydrocarbon, substantially as set forth.

5. A composition for phonograph record-blanks, comprising stearate and palmitate of soda, stearate and palmitate of lead, oleate of

lead, and an acid resin, substantially as set forth.

6. A composition for phonograph record-blanks, comprising stearate and palmitate of soda, stearate and palmitate of lead, oleate of lead, an acid resin, and a hydrocarbon, substantially as set forth.

This specification signed and witnessed this 25th day of July, 1900.

JONAS WALTER AYLSWORTH.

Witnesses:
J. F. Randolph,
J. A. Boehne.

No. 683,615. Patented Oct. 1, 1901.

## W. H. MILLER & J. W. AYLSWORTH.

## METHOD OF DUPLICATING PHONOGRAPHIC RECORDS.

(Application filed July 31, 1900.)

(No Model.)

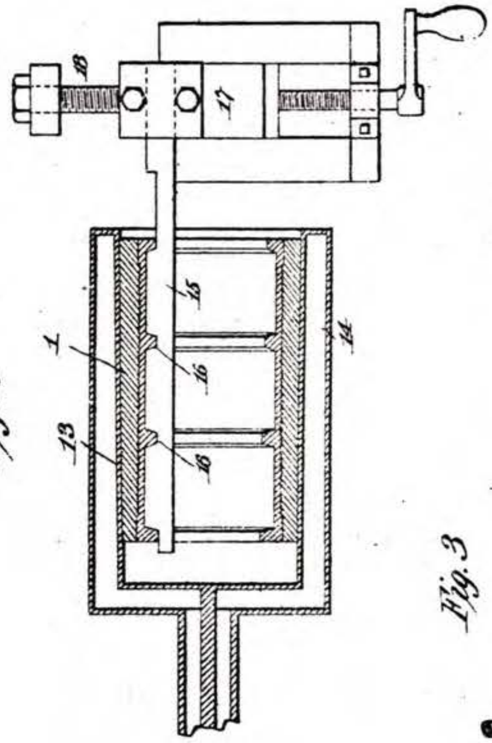


Fig. 2

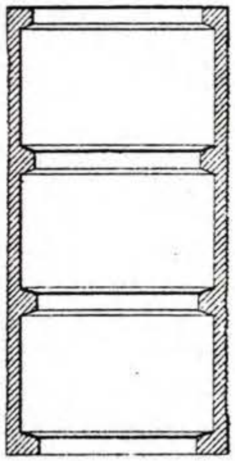


Fig. 4

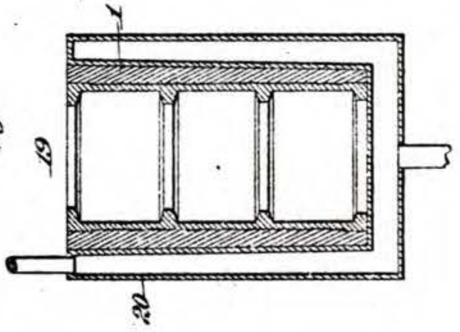


Fig. 3

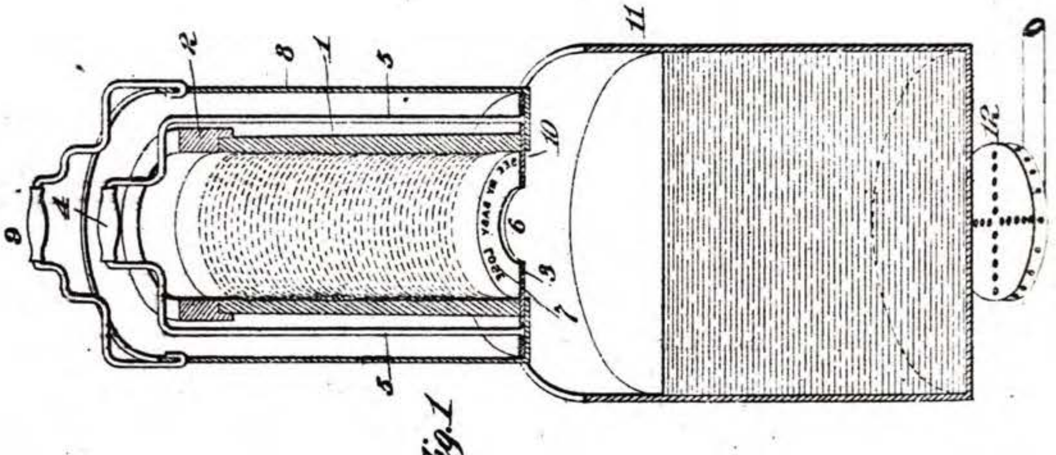


Fig. 1

**Witnesses:**

Jas. F. Coleman

Jno. R. Taylor

**Inventors**

Walter Henry Miller

Jonas Walter Aylsworth

by Dyer Edmonds & Dyer Att'ys

# UNITED STATES PATENT OFFICE.

WALTER HENRY MILLER, OF ORANGE, AND JONAS WALTER AYLSWORTH, OF EAST ORANGE, NEW JERSEY, ASSIGNORS TO NATIONAL PHONOGRAPH COMPANY, OF ORANGE, NEW JERSEY.

## METHOD OF DUPLICATING PHONOGRAPHIC RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 683,615, dated October 1, 1901.

Application filed July 31, 1900. Serial No. 25,391. (No specimens.)

*To all whom it may concern:*

Be it known that we, WALTER HENRY MILLER, of Orange, and JONAS WALTER AYLSWORTH, of East Orange, in the county of Essex and State of New Jersey, citizens of the United States, have invented a certain new and useful Method of Duplicating Phonographic Records, of which the following is a description.

Our invention relates to an improved process of duplicating phonographic records; and our object is to provide a process by which the duplicating of phonographic records can be carried on expeditiously and economically and duplicate records produced which are of superior quality.

In carrying our invention into effect we first secure a matrix or mold from which copies are to be produced, said matrix or mold being made by any suitable and approved process—as, for instance, by a process of electroplating on a vacuous deposit preliminarily secured upon an original phonographic cylinder, the electroplating being suitably backed up and strengthened by a metal jacket and the original cylinder being removed from the electroplated coating in any suitable way, as by melting the record or by contracting it by cold. The resulting matrix will obviously be a cylinder carrying on its bore a representation in negative or relief of the original record. From the matrix or mold secured in this or in any other approved way we make duplicates by a process of immersion or dipping of the matrix or mold in a bath of molten wax-like material from which the duplicates are to be secured, whereby a coating or covering of such material will be deposited upon the interior of the matrix or mold by reason of the lower temperature of the matrix or mold. After thus securing a sufficiently thick coating of material on the interior of the matrix or mold we remove the latter from the bath, carrying the deposited material with it, and we properly finish the duplicate so secured by reaming its interior to gage, trimming one of its ends, and afterward shrinking the duplicate from the matrix or mold.

In carrying out our improved process we may utilize any suitable apparatus for the purpose, and the apparatus illustrated in the accompanying drawings, which form a part of this specification, is merely an illustrative one and we do not wish to be limited thereto.

In the drawings, Figure 1 is a sectional view of the apparatus and mold in which the deposit or coating of the wax-like material is secured; Fig. 2, a corresponding view of the apparatus for properly reaming the interior of the duplicates; Fig. 3, a similar view of the apparatus employed for the shrinking of the duplicates from the matrix or mold, and Fig. 4 an enlarged corresponding view of one of the resulting duplicates.

In all of the above views corresponding parts are represented by the same numerals of reference.

1 represents a matrix or mold carrying on its bore the representation of the record which is to be duplicated, said representation being obviously in negative or relief. This matrix or mold is made by any approved process and is not a part of our invention.

2 is a metal cap which is removably fitted upon the upper end of the matrix or mold, with its bore corresponding in diameter with the bore of the matrix or mold.

3 is a metal disk provided with a handle 4, connected to side bars 5 5 and by which the disk may be manipulated. The matrix or mold 1 is carried by the disk 3, as shown. An opening 6 in the disk 3 is of considerably less diameter than the bore of the matrix or mold, and around said opening 6 and within the bore of the matrix or mold the disk may be formed in negative with a representation 7 of suitable words or characters to indicate the subject-matter of the duplicated record, its source of origin, &c.

8 is a sheet-metal receptacle provided with a handle 9 and which carries the disk 3 and the matrix or mold 1, as shown. The receptacle 8 is provided with an opening 10 therein, which may be of the same or of larger size than the opening 6 in the disk 3.

11 represents a tank which contains, as indicated, a proper supply of suitable wax-like material from which the duplicates are to be made and which material may be the

ordinary commercial phonographic compositions now in use. The material in the tank 11 may be kept in a molten condition by heat applied in any suitable way, as by means of a gas-burner 12.

In carrrying out our process with the apparatus so far described we place the matrix or mold on the disk 3 and insert the latter, carrying the matrix or mold in the receptacle 8, as shown, after which the receptacle 8 is immersed in the molten material within the tank 11, which is permitted to enter the matrix or mold to a point above the upper end of the latter, but below the top of the cap 2, so that the material fills the interior of the matrix or mold, but does not overflow the same. The matrix or mold is thus kept immersed in the molten material for the desired time required to secure a deposit of the wax-like material of the required thickness. With the ordinary commercial phonographic composition now used maintained at from 20° to 40° above its melting-point and with a matrix or mold having a thickness of about one-fourth of an inch a deposit of material will be formed on the interior of the matrix or mold of the desired thickness after an immersion of about three minutes. Obviously, however, this time will vary with the peculiar conditions under which the process may be carried out; but in no instance should the matrix or mold be immersed within the molten material for a long enough time to allow its temperature to be raised sufficiently to permit the deposited molten material thereon to become remelted. The reduced temperature of the matrix or mold relative to the temperature of the molten material causes the latter to become coagulated or chilled on the interior of the matrix and to deposit thereon to the thickness desired. This chilling also makes the outer surface of the resulting duplicates much smoother than is the case with duplicates made by a mechanical duplicating process. Owing to the thinness of the walls of the receptacle 8 the metal thereof very quickly attains the temperature of the molten material, so that none of the molten material will accumulate thereon. It will be understood that the matrix or mold may be made of increased thickness or be artificially cooled before the dipping operation when the composition is of a character requiring an increased cooling effect to secure the desired thickness of deposit. When the desired deposit of molten material is secured, the receptacle 8 is removed from the bath of molten material and the disk 3, carrying the mold, is removed from said receptacle. Obviously the lower edge of the resulting duplicate will be perfectly true, being formed by the portion of the disk 3 between the opening 6 and the bore of the matrix or mold, and if a representation 7 is formed on that portion of the disk such representation will be cast in the bottom end of the duplicate. The cap 2 is now removed from the matrix or mold and the upper end of the duplicate is trimmed off flush with the upper surface of the matrix or mold by any desired form of cutting-tool. The matrix or mold, which has a slightly-tapered outer surface, is now placed in a tapered chuck 13, as shown in Fig. 2, which chuck is provided with a water-jacket 14, through which cold water may circulate in order that the matrix or mold may be kept cold enough to maintain the resulting duplicate or at least the outer surface thereof in a chilled and hardened condition. The chuck 13 being rotated in any suitable way, a reaming-tool 15, held at an angle to give the desired taper to the bore of the duplicate, is introduced within the same, and by reason of the cut-away portions 16 in said reaming-tool a series of ribs will be formed on the duplicate, as shown in Fig. 4, by which the latter will be properly held upon the mandrel of the reproducing-phonograph in the usual way. The reaming-tool 15 is carried by the usual slide-head 17 of the lathe, and the depth of cut of said tool is limited by a regulating-screw 18, as shown. This reaming of the interior of the duplicate is preferably carried on before the resulting duplicate has cooled sufficiently to become hard and before it has contracted from the bore of the matrix, whereby the reaming operation can be carried on effectively and smoothly. After the interior of the duplicate has been properly reamed, as explained, the matrix or mold is removed from the chuck 13 and inserted in a cooling-mold 19, having a water-jacket 20 and through which cold water may circulate, the matrix or mold being kept in the cooling-mold until the resulting duplicate has contracted sufficiently to enable it to be removed from the matrix or mold, whereupon the operation will be completed. By reaming the interior of the resulting duplicates, as explained, to form a series of ribs therein the duplicates may be made much thinner than the ordinary original records, and hence more economically, it being of course understood that the material removed by the reaming-tool will be used for the manufacture of subsequent duplicates.

While our improved process is particularly adapted for the manufacture of duplicate records, it will be understood that the process may be carried out in connection with the manufacture of phonograph-blanks by employing a matrix or mold having a smooth bore, in which a deposit may accumulate by a process of immersion, as described. The deposited blank will be reamed on its interior, trimmed on its outer edge, and removed by shrinking or otherwise in exactly the same way as that described in connection with the manufacture of duplicate records. Such a process not only provides for the cheap and effective manufacture of phonograph-blanks, but by its carrying out a superior article is produced, since the record-surface of the blanks will be smooth and calendered in appearance. With such blanks therefore after having received a record in any suitable way the reproduction will be smoother and freer of extraneous sounds than reproductions obtained from records made on other blanks.

We do not claim herein the apparatus above described for carrying our invention into effect, since such apparatus is made the subject of our companion application filed on even date herewith and numbered serially 25,392.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is as follows:

1. The method of making a cylindrical phonographic surface, which consists in immersing a continuous tubular mold in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the mold and will chill thereon in a layer of the desired thickness, then in contracting the deposited material, and finally in removing it longitudinally from the mold, substantially as set forth.

2. The method of duplicating phonographic records, which consists in immersing a continuous cylindrical mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, then in contracting the deposited material, and finally in removing it by a direct longitudinal movement from the matrix or mold, substantially as set forth.

3. The method of duplicating phonographic records, which consists in immersing a mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, in finishing the bore of the duplicate so secured, and in separating the duplicate from the matrix or mold, substantially as set forth.

4. The method of duplicating phonographic records, which consists in immersing a mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, in finishing the bore of the duplicate so secured, and in shrinking the duplicate from the matrix or mold, substantially as set forth.

5. The method of duplicating phonographic records, which consists in immersing a mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, in finishing the bore of the duplicate so secured before the latter has become hard, and in separating the duplicate from the matrix or mold, substantially as set forth.

6. The method of duplicating phonographic records, which consists in immersing a matrix or mold carrying the record in relief on its bore in a molten wax-like coagulable material which is excluded from the exterior of the matrix or mold and only enters the bore thereof, whereby the reduced temperature of the matrix or mold causes the material to chill on the bore and accumulate in a layer of the desired thickness, in removing the matrix or mold from the molten material, in trimming the bore of the duplicate so secured, and in separating the duplicate from the matrix or mold, substantially as set forth.

7. The method of duplicating phonographic records, which consists in immersing a matrix or mold carrying the record in relief on its bore in a molten wax-like coagulable material which is excluded from the exterior of the matrix or mold and only enters the bore thereof, whereby the reduced temperature of the matrix or mold causes the material to chill on the bore and accumulate in a layer of the desired thickness, in removing the matrix or mold from the molten material, then in maintaining the reduced temperature of the matrix or mold while the interior of the duplicate is finished, and finally in further reducing the temperature of the matrix or mold to cause the resulting duplicate to be contracted, whereby it may be removed by a direct longitudinal movement, substantially as set forth.

This specification signed and witnessed this 17th day of July, 1900.

WALTER HENRY MILLER.
JONAS WALTER AYLSWORTH.

Witnesses:
J. L. EVANS,
HENRY WACHENFELD.

No. 683,979. Patented Oct. 8, 1901.

# A. N. PETIT.

## DEVICE FOR MAKING DUPLICATE SOUND RECORDS.

(Application filed Dec. 8, 1900.)

**(No Model.)**

Fig. 1.

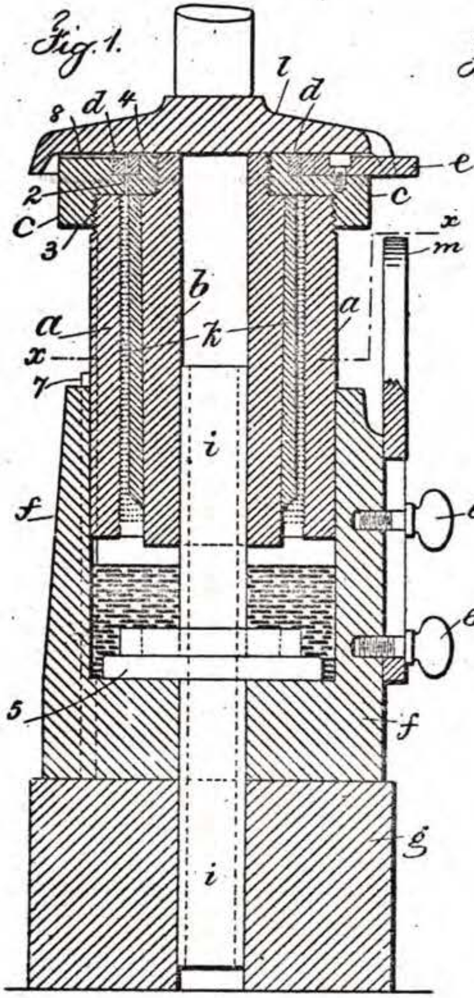


Fig. 4.

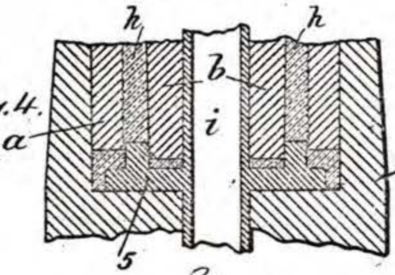


Fig. 5.

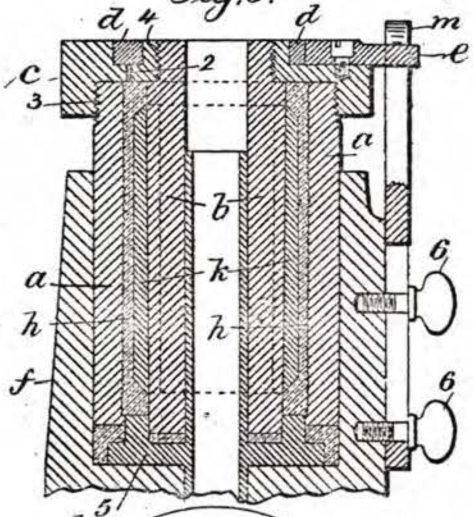


Fig. 3.

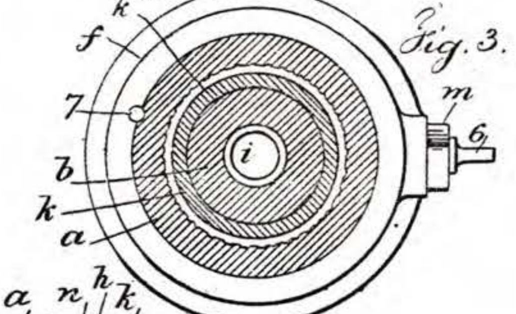


Fig. 2.

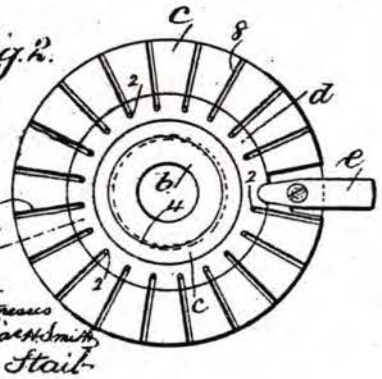
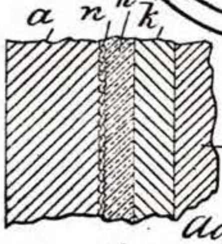
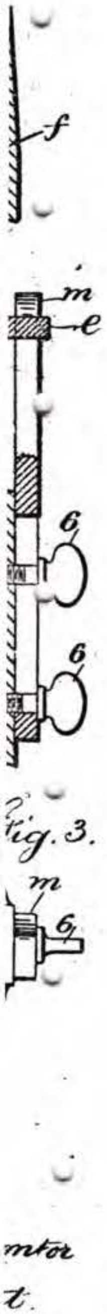


Fig. 6.



Witnesses
Chas H. Smith
J. Stail

Inventor
Ademor N. Petit
per L. W. Serrell & Son
attys



# UNITED STATES PATENT OFFICE.

ADEMOR N. PETIT, OF NEWARK, NEW JERSEY, ASSIGNOR TO HIMSELF AND ALBERT O. PETIT, OF SAME PLACE.

## DEVICE FOR MAKING DUPLICATE SOUND-RECORDS.

**SPECIFICATION forming part of Letters Patent No. 683,979, dated October 8, 1901.**

Application filed December 8, 1900. Serial No. 39,126. (No model.)

*To all whom it may concern:*

Be it known that I, ADEMOR N. PETIT, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented an Improvement in Devices for Making Duplicate Sound-Record Cylinders, of which the following is a specification.

Heretofore phonogram-blanks have been manufactured of a wax composition cast in a mold and thereafter trued with heated tools, and the record of sound has been thereafter engraved or cut thereon, and matrices of such sound-records have been formed and duplicate records made therefrom.

My present invention relates to devices for making such duplicate sound-records. These are preferably made of cylindrical form, and the essential feature of the present invention is in so forming the duplicate sound-record within a matrix as to finish both ends of the cylinder to obviate the after-necessity of turning down or truing the ends.

According to my present invention the duplicate sound-record cylinder may be made of even thickness throughout or thicker in one part than another or with thickened ends, and I may employ a hollow core that has parallel sides or which is tapering to conform in size with the taper mandrel of a phonograph or record-reproducing machine.

I employ a matrix of a sound-record, made in any manner well-known in the art, a hollow core, and a device to which both the matrix and the hollow core are connected, a perforated hollow base, and a tubular center received within the hollow core and base and which base receives the matrix, and means for forcing the matrix and core down into the base and causing composition material therein rendered fluid by heat to flow upward between the matrix and core under pressure to fill the interstices of the matrix and when set cooled and removed to form the duplicate sound-record cylinder. I provide means for the escape of the confined air and thereafter of a small quantity of the fluid composition to prove the absence of the air, and which means are closed or shut off before final pressure is applied to consolidate the composition material, and I provide means in connection with the tubular center to pass in between the matrix and the hollow core, so as to finish complete one end of the duplicate sound-record cylinder while the other end is finished against the device or head connecting the matrix and hollow core. I may employ, surrounding the hollow core, a segmental sleeve, preferably somewhat shorter than the length of the finished duplicate sound-record cylinder and which segmental sleeve completely surrounds the hollow core, with one or both ends beveled, the office of the segmental sleeve being to reduce the thickness of a portion of the duplicate sound-record cylinder and leave one or both of the ends thickened, or, in other words, with inwardly-projecting rings or flanges, the diameter of which agrees with the mandrel of the machine, while the internal diameter of the cylinder is somewhat greater.

In the drawings, Figure 1 is a vertical section and partial elevation representing my improvement. Fig. 2 is a plan with the cap of the press removed. Fig. 3 is a cross-section at $x\ x$ of Fig. 1. Fig. 4 is a partial vertical section representing the simpler form of my invention. Fig. 5 is a partial vertical section representing a modification, and Fig. 6 is a detached vertical section of some of the parts shown in Figs. 1 and 5 upon a larger scale.

I prepare the matrix *a* in any manner well-known in the art—that is to say, with a substantial backing, one end of which is made with a peripheral screw-thread.

The hollow core is represented at *b*. This may be provided with parallel sides, or it may be tapering to agree in size and form with the mandrel of a phonograph or record-reproducing machine. One end of the hollow core is reduced and provided with a peripheral screw-thread.

I employ a head device *c* with an open center and with a peripheral flange. The inner surface of the flange is made with an annular screw-surface 3 and the inner surface of the head with a screw-surface 4. The head is provided with an annular groove in the upper face to receive the ring *d*. The ring *d* is provided with perforations at spaced-apart intervals, and the head *c* is also provided with perforations 2, which in one position of the ring agree with the perforations therein. The surfaces of the head *c* and ring *d* are provided with radial grooves 8, which extend from the perforations in the ring to the periphery of the head. The matrix *a* is connected to the head at the screw-thread 3, and the hollow core *b* is connected to the head at the screw-thread 4, so that the hollow core occupies a position concentric to the matrix, and the said head serves to hold the matrix and hollow core in a fixed relation to one another. This ring *d* is provided with a notched portion in its periphery, and the head is cut away to receive a swinging arm *e*, connected thereto by a screw forming a pivot for the arm, and the arm is provided with a curved end bearing in the recess of the ring *d*, the movement of the arm serving to impart a partial rotation to the ring, it being a fact that in one position of the ring, such as shown in Fig. 1, the perforations of the head and the ring coincide, while if the arm *e* is moved from the position shown in Fig. 2 the ring *d* is partially rotated to close off the respective perforations.

A hollow base *f* is preferably supported upon a pedestal *g*, also made hollow, and the hollow base *f* receives the matrix *a*, there being by preference a guide-pin 7 passing down through a groove made in the inner surface of the hollow base, a groove being provided in the vertical surface of the matrix also to fit the guide-pin 7, so as to prevent the matrix turning in its relation to the hollow base as the same moves vertically therein.

I provide a tube *i*, forming a center, a part of which passes through the opening in the hollow base *f* and into the opening in the pedestal *g* and the other end of which extends upward into the opening in the hollow core *b*, and upon this tube *i* is a flanged disk 5, (shown by elevation in Fig. 1 and cross-section in Figs. 4 and 5,) the flange of the disk being of a width agreeing with the opening between the matrix and the hollow core.

A device analogous to the present has been employed by me, but therein there was no provision, as in the present, for finishing both ends of the duplicate sound-record cylinder *h*.

The hollow base *f* receives material rendered plastic or fluid by heat, and the matrix and hollow core fitting within the hollow base are forced down into the said material by the cap *l* of a suitable press, which cap rests above and upon the head *c*. In this movement as the matrix and core descend the air passes out of the perforations in the head and ring and escapes by the radial grooves 8, and the composition in a fluid or plastic state rises between the matrix and the hollow core, filling the space therein, some of the composition possibly escaping through the openings in the head and ring, and as the parts arrive at this position a cam *m*, vertically adjustable by clamp-screws 6, strikes the arm *e*, swinging the same and giving a partial rotation to the ring *d*, so as to move the perforations in the ring out of alinement with those in the head to cut off the composition and hold the same within the mold. The further downward movement by pressure upon the matrix and core compresses the composition material into the mold and the flange of the disk 5 passes in between the matrix *a* and hollow core *b*, thus preventing any more of the composition getting into the mold and at the same time pressing together into a firm and compact mass the composition within the mold in making the duplicate sound-record cylinder *h* and at the same time finishing one end of the cylinder against the under surface of the head *c* and the other end of the cylinder against the face of the flange of said disk. In this manner both ends of the cylinder *h* are finished. I prefer thereafter to pass water through the tube *i* to cool the hollow core and chill the composition material from inside outward, so that the same is cooled preparatory to the removal of the duplicate sound-record cylinder *h* from the parts in any suitable or desired manner, and in which the head *c* is simultaneously separated from the matrix *a* and the core *b* at the screw-threads 3 4. I prefer to employ, in connection with this device by which both ends of the duplicate sound-record cylinder *h* are simultaneously finished, a segmental sleeve *k*, surrounding the hollow core *b* and made shorter than the matrix. One or both ends of the segmental sleeve are tapered. In Fig. 1 I have shown one end as tapered, while in Fig. 5 both ends are shown as tapered. Where one end is tapered, the duplicate sound-record cylinder *h* is made thinner in the portion coming between the segmental sleeve *k* and the matrix, and the end adjacent to the flanged disk 5 is made of full thickness between the matrix and core, so that this latter end is thickened or made with a flange, the opening in which agrees with the diameter of the mandrel. Both ends may be made with thickened portions or rings, as shown in Fig. 5, in which the segmental sleeve *k* is shorter with both ends tapered, and in this case the duplicate sound-record cylinder *h* is provided with its respective ends made thicker or with flanges, the central portion being within of greater diameter than the ends, but with sufficient strength and rigidity for service. In any event both ends of the duplicate sound-record cylinder *h* are finished, so as to require no after turning down or treatment, one end being finished against the under surface of the head *c* and the other against the surface of the flange of the disk 5.

In the modification shown in Fig. 6 I have shown at *n* a film upon the surface of the matrix *a*, as it is possible in my present invention to first form a film upon the matrix and afterward, as hereinbefore described, to force the fluid composition material up into the mold past the film and by pressure and heat to cause the film and composition to adhere, so that the finished sound-record cylinder has a film-surface in which is the record and the foundation or body of inferior or cheaper material, the parts being united by adhesion under heat and pressure. In this connection, however, it is preferable that the foundation material have in its composition a material of a solvent nature bearing a close relation to the materials of the film, so that the union of the film and composition will be chemical as well as mechanical. The film is preferably composed of celluloid or a composition of pyroxylin and other suitable materials, and the foundation is preferably composed of pyroxylin, camphor, and a greater quantity of a pigment—such as zinc-white, kaolin, baryta, magnesium, red lead, colored mineral earth, or similar suitable materials—which by reason of their presence and bulk cheapen the material forming the foundation.

The segmental sleeve *k* may consist of any desired or advantageous number of parts held together and to the hollow core *b* in any suitable manner, it being necessary to support the sleeve *k* upon and by the said core; but the same forms no part of the present invention.

I do not herein limit myself to the composition of the material rendered fluid or plastic by heat and employed for making the duplicate sound-record nor to the material of which the film is composed.

I claim as my invention—

1. The combination with a matrix, a hollow core and a device to which the said parts are connected at one end, of a hollow base adapted to receive the matrix and composition material rendered fluid or plastic by heat, a tube forming a center and passing into the opening in the hollow base and up into the hollow core, a disk connected to said tube within the hollow core and adjacent to the inner surface thereof and having an annular flange agreeing in width and in diameter with the lower end of the space between the matrix and hollow core, substantially as and for the purposes set forth.

2. The combination with the matrix having a screw-thread at one end and a hollow core reduced and having a screw-thread at one end, of a head having an open screw-threaded center to receive the hollow core, and to which the same is connected, and an internally-threaded flange to which the matrix is connected so that the hollow core is concentric to the matrix and the under surface of the head closes the annular opening between the matrix and hollow core at one end, a hollow base receiving the matrix and hollow core and the annular flange adapted to pass between the matrix and hollow core at the end opposite to that occupied by the connecting-head, substantially as and for the purposes set forth.

3. The combination with the matrix having a screw-thread at one end and the hollow core reduced and having a screw-thread at one end, of a head having a series of perforations an open screw-threaded center to receive the hollow core and to which the same is connected, and an internally-threaded flange to which the matrix is connected so that the hollow core is concentric to the matrix and the under surface of the head closes the annular opening between the matrix and hollow core at one end, a ring having spaced-apart perforations and received in an annular groove in the outer surface of the head concentric to the hollow core, the perforations in the ring agreeing normally with perforations in the head, means for imparting a partial rotation to the ring to close off the perforations, a hollow base within which the matrix and hollow core are received, a tube passing down through the hollow base and up into the hollow core, and a disk surrounding and connected to the tube and lying against the inner horizontal surface of the hollow base, and an annular flange formed with and rising from the said disk and agreeing in width and diameter with the opening between the matrix and hollow core at the ends thereof opposite to the head, and means for forcing down the matrix and hollow core into the hollow base so as to force up between the matrix and hollow core material in the base rendered fluid or plastic by heat to form between the matrix and hollow-core a duplicate sound-record cylinder with finished ends, substantially as set forth.

4. The combination with the matrix having a screw-thread at one end and the hollow core reduced and having a screw-thread at one end, of a head having a series of perforations an open screw-threaded center to receive the hollow core and to which the same is connected, and an internally-threaded flange to which the matrix is connected so that the hollow core is concentric to the matrix and the under surface of the head closes the annular opening between the matrix and hollow core at one end, a segmental sleeve surrounding the hollow core and shorter in length than the length of the matrix and having at least one end tapered, a ring having spaced-apart perforations and received in an annular groove in the outer surface of the head concentric to the hollow core, the perforations in the ring agreeing normally with perforations in the head, means for imparting a partial rotation to the ring to close off the perforations, a hollow base within which the matrix and hollow core are received, a tube passing down through the hollow base and up into the hollow core, and a disk surrounding and connected to the tube and lying against the inner horizontal surface of the hollow base and an annular flange formed with and rising from the said disk and agreeing in width and diameter with the opening between the matrix and hollow core at the ends thereof opposite to the head, and means for forcing down the matrix and hollow core into the hollow base so as to force up between the matrix and hollow core material in the base rendered fluid or plastic by heat to form between the

matrix and hollow core a duplicate sound-record cylinder with finished ends, substantially as and for the purposes set forth.

5. The combination with the matrix having a screw-thread at one end and a hollow core reduced and having a screw-thread at one end, of a head having screw-threaded portions to receive the hollow core and the matrix and to which the same are connected so that the hollow core is concentric to the matrix and the under surface of the head closes the annular opening between the matrix and hollow core at one end, a segmental sleeve surrounding the hollow core and shorter in length than the length of the matrix and having at least one end tapered, a hollow base within which the matrix and hollow core are received, a tube filling the axial center of the hollow core and hollow base, a disk having an integral annular flange rising from the same and which flange agrees in width and diameter with the opening between the matrix and hollow core at the ends thereof opposite to the head, said disk being connected to said tube and within the hollow base against the horizontal inner surface thereof, whereby in the forming of the duplicate sound-record cylinder the flange of said disk passes in between the matrix and hollow core to finish one end of the duplicate sound-record cylinder while the other end is finished against the under surface of the head, substantially as and for the purposes set forth.

Signed by me this 3d day of December, 1900.

ADEMOR N. PETIT.

Witnesses:

GEO. T. PINCKNEY,

BERTHA M. ALLEN.

No. 689,117. Patented Dec. 17, 1901.

## A. N. PETIT.

## DUPLICATE SOUND RECORD CYLINDER FOR PHONOGRAPHS.

(Application filed Mar. 18, 1901.)

**(No Model.)**

Fig. 3.

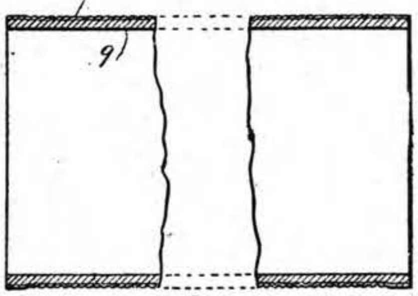


Fig. 4.

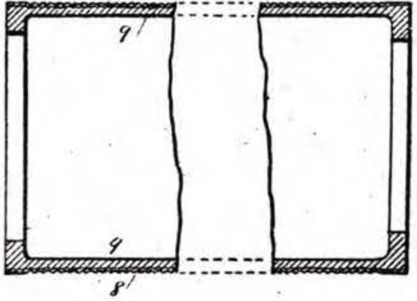
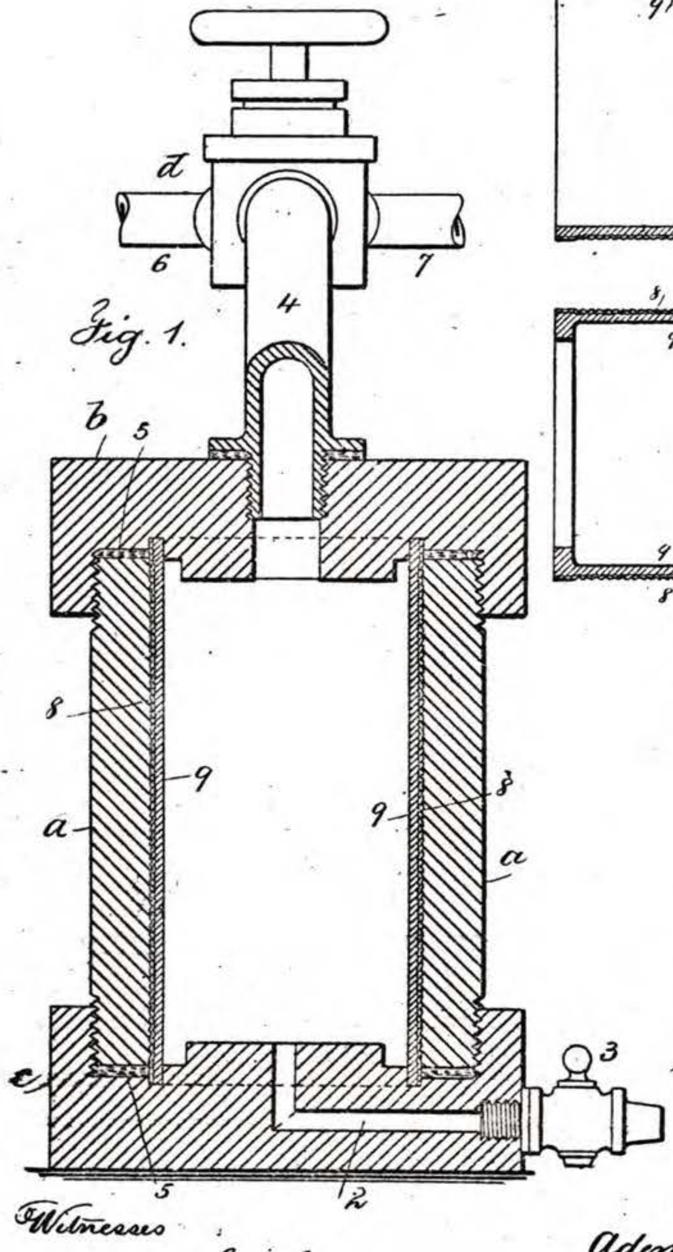


Fig. 1.



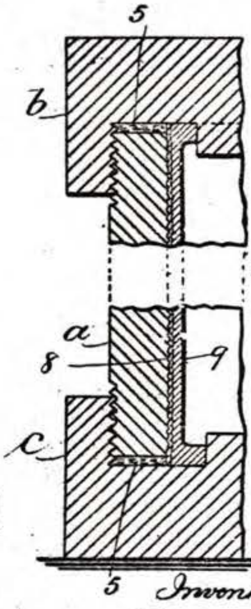


Fig. 2

Witnesses

Chas. H. Smith

J. Staib

Inventor

Ademor N. Petit.

per L. W. Serrell & Son

att'ys

# UNITED STATES PATENT OFFICE.

ADEMOR N. PETIT, OF NEWARK, NEW JERSEY.

## DUPLICATE SOUND-RECORD CYLINDER FOR PHONOGRAPHS.

**SPECIFICATION forming part of Letters Patent No. 689,117, dated December 17, 1901.**

Original application filed December 8, 1900, Serial No. 39,127. Divided and this application filed March 18, 1901. Serial No. 51,595. (No model.)

*To all whom it may concern:*

Be it known that I, ADEMOR N. PETIT, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented an Improvement in Duplicate Sound-Record Cylinders for Phonographs and Similar Machines, of which the following is a specification.

My present application is a division of my application for Letters Patent filed December 8, 1900, Serial No. 39,127.

My invention relates to a new article of manufacture—that is, a duplicate sound-record cylinder for phonographs and similar machines, made in a matrix.

In carrying out my invention the duplicate sound-record is composed of a surface film or body of suitable material carrying a record of sound and a foundation of a different or inexpensive material connected thereto by cementing adhesion under heat and pressure. For this surface film I prefer to employ celluloid and for the foundation an inexpensive material of any desired character, such as celluloid loaded with pigment to give body and carrying a surface impregnation of a material of a solvent nature, such as amyl acetate, for the celluloid, the parts being connected together by cementing adhesion under heat and pressure. For this surface film I may also employ gelatin, lac, glue, gum, collodion, or similar material. For these materials there is one or more solvents, and the foundation carries a surface impregnation of a solvent, such as is employed for the surface film. Consequently when in the manufacture heat and pressure are employed the heat softens the foundation, as well as the surface film, and causes an action of the solvents of the film and foundation, which acting together with the heat and pressure have a cementing adhesion to permanently connect the surface film and the foundation.

The method of manufacturing this duplicate sound-record cylinder is set forth in my aforesaid application, and while I do not limit myself to the method employed for manufacturing the same the method employed in said application is the preferable one.

In the drawings, Figure 1 is a vertical section of an apparatus adapted for the manufacture of my duplicate sound-record cylinder and showing a cylinder with plain ends. Fig. 2 is a partial vertical section of the apparatus, showing the cylinder with inturned ends or flanges. Fig. 3 is a broken section of a cylinder such as is shown in the apparatus Fig. 1, and Fig. 4 a broken section of a cylinder such as is shown in the partial section of the apparatus Fig. 2.

The apparatus is described in an application of like date herewith, and while I prefer this form of apparatus I do not limit myself thereto. The improved apparatus in which this article of manufacture is made comprises a cylindrical matrix *a*, a head *b*, connected by a threaded flange to one end of the said matrix, and a base *c*, connected also by a threaded flange to the other end of the said matrix in a similar manner, there being packings 5 preferably between the ends of the matrix and the inner surface of the head and base, so as to secure a tight joint against steam and compressed air. The base *c* is preferably provided with an exit-opening 2 and an escape-cock 3, and the head is preferably provided with a central opening, to which is connected a pipe 4, and a three-way cock *d* is connected to the pipe 4, and from the opposite sides of this there are a steam-pipe 6 and a pipe 7 for compressed air.

8 represents the surface-film duplicate sound-record, and 9 the foundation or cylindrical shell. The apparatus is preferably made, as shown, with annular grooves to receive the ends of the foundation, with the object of insuring the steam and air pressure doing the work and preventing the same getting in between the foundation and skin. With the matrix separated and disconnected from the head and base the inner surface of the matrix is to be coated to any desired thickness by a material such as hereinbefore set forth and in a fluid state. This material may be applied by a brush or by centrifugal action, or both, so as to impart to the matrix-surface an even homogeneous film until the desired thickness is obtained, after which said film is preferably allowed to set or dry, so as to yield an impression of the matrix. The film thus obtained is firm, dense, and yet flexible. The foundation 9 or cylindrical

shell should fit closely within the film thus formed upon the surface of the matrix, and this foundation may be made with integral inturned ends or flanges or not. Figs. 1 and 3 show the duplicate sound-record cylinder without inturned ends, while Figs. 2 and 4 show the foundation with inturned ends, and in the article I do not limit myself to the form of the ends. In the operation of manufacture and after the film is formed and the foundation placed within the same and the parts of the apparatus connected up, as shown in Fig. 1, steam is admitted within the matrix through the pipe 6, the three-way cock *d*, and the pipe 4, so as to soften the foundation and the surface film upon the matrix, and the steam being of pressure expands the foundation, bringing the same into intimate contact with the surface film, and the foundation and the film are united by the cementing adhesion of heat and pressure. This action is made all the more sure and positive where the surface of the foundation is impregnated with a solvent material of the same character as that employed in the surface film. After the heat has been maintained, together with the steam, a sufficient time the same is turned off at the three-way cock, and compressed air is admitted by the pipe 7, the escape-cock 3 being opened to drive out the steam until the compressed air entirely fills the space within the matrix, when the three-way cock is closed and the compressed air admitted of full force. The pressure of the compressed air is maintained within the matrix to hold the duplicate sound-record in shape until the same is thoroughly cooled and set, and this operation may be facilitated by the application of a cold or a cooling liquid to the exterior of the matrix or entire apparatus. This cooling action produces a slight shrinking in the duplicate sound-record cylinder, so that after the head or base is separated from the matrix the cylinder is readily removed therefrom.

I claim as my invention—

1. As a new article of manufacture, a duplicate sound-record cylinder composed of a surface film of suitable material carrying a record of sound and a foundation of a different and inexpensive material connected thereto by cementing adhesion under heat and pressure, substantially as set forth.

2. As a new article of manufacture, a duplicate sound-record cylinder composed of a surface film of celluloid carrying a record of sound and a foundation of inexpensive material carrying a surface impregnation of a material of a solvent nature connected thereto by cementing adhesion under heat and pressure, substantially as set forth.

3. As a new article of manufacture, a duplicate sound-record cylinder composed of a surface film of suitable material carrying a record of sound and a foundation of inexpensive material carrying a surface impregnation of the same solvent material as that employed for the surface film connected thereto by cementing adhesion under heat and pressure, substantially as set forth.

4. As a new article of manufacture, a duplicate sound-record cylinder composed of a surface film of suitable material and a foundation of a different and inexpensive material connected thereto by cementing adhesion under heat and pressure, substantially as set forth.

5. As a new article of manufacture, a duplicate sound-record cylinder composed of a surface film of celluloid and a foundation of inexpensive material carrying the surface impregnation of a material of a solvent nature connected thereto by cementing adhesion under heat and pressure, substantially as set forth.

6. As a new article of manufacture, a duplicate sound-record cylinder composed of a surface film of suitable material and a foundation of inexpensive material carrying a surface impregnation of the same solvent nature as that employed for the surface film connected thereto by cementing adhesion under heat and pressure, substantially as set forth.

Signed by me this 13th day of March, 1901.

ADEMOR N. PETIT.

Witnesses:
GEO. T. PINCKNEY,
S. T. HAVILAND.

No. 713,209. Patented Nov. 11, 1902.

# T. A. EDISON.

## PROCESS OF DUPLICATING PHONOGRAMS.

(Application filed Mar. 5, 1898.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1a

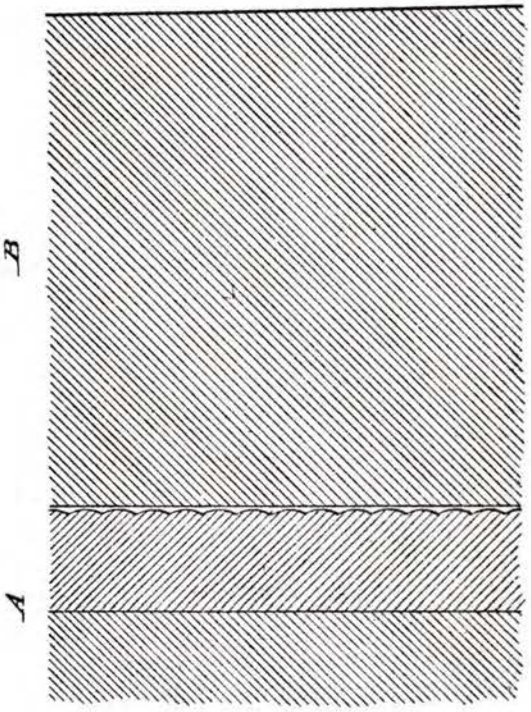
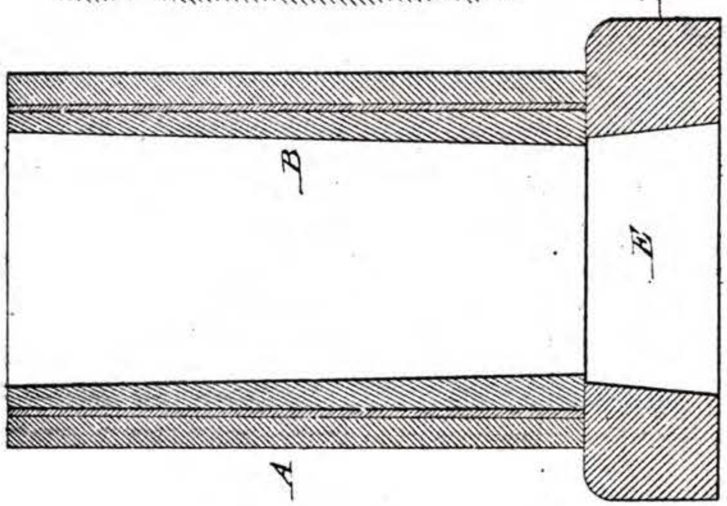


Fig. 1



Witnesses:
Jas. F. Coleman
Jno. Robt Taylor

Inventor
Thomas A Edison
by Dyer Edmonds & Dyer
Att'ys.

No. 713,209. Patented Nov. 11, 1902.

# T. A. EDISON.

## PROCESS OF DUPLICATING PHONOGRAMS

(Application filed Mar. 5, 1898.)

(No Model.) 3 Sheets—Sheet 2.

Fig. 2a

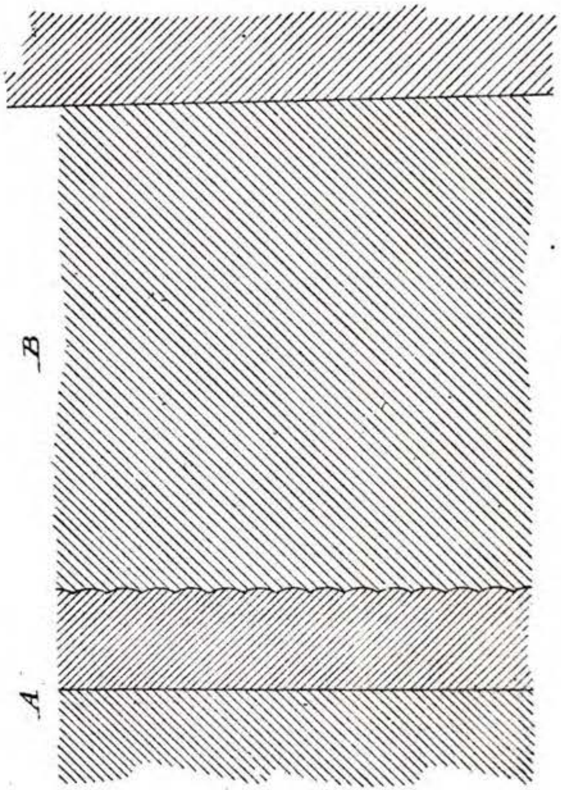
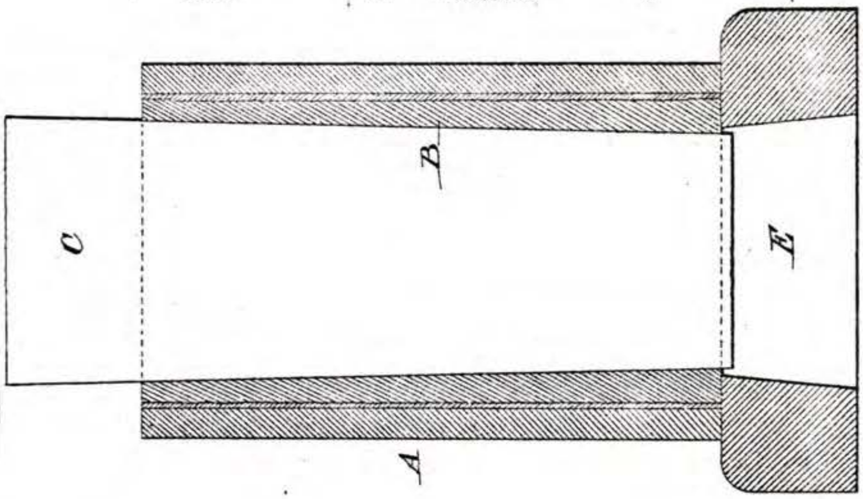


Fig. 2



Witnesses:

Jas. F. Coleman

Jno. Robt Taylor

Inventor

Thomas A Edison

by Dyer Edmonds & Dyer

Att'ys

No. 713,209. Patented Nov. 11, 1902.

# T. A. EDISON.

## PROCESS OF DUPLICATING PHONOGRAMS.

(Application filed Mar. 5, 1898.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 3a

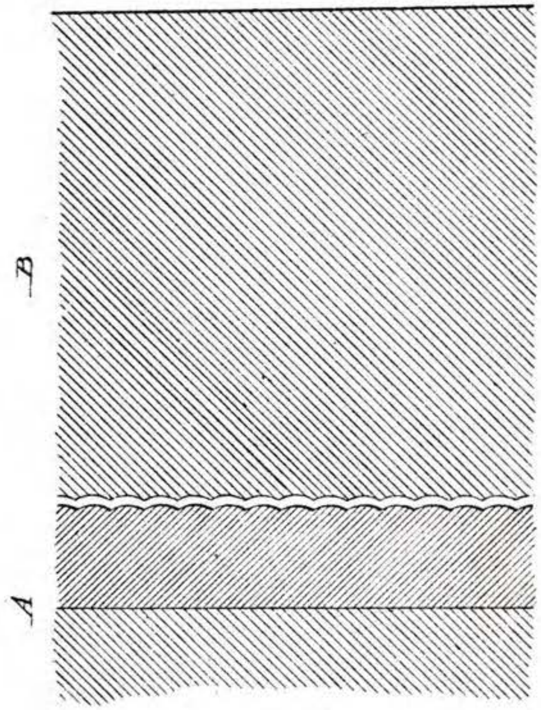
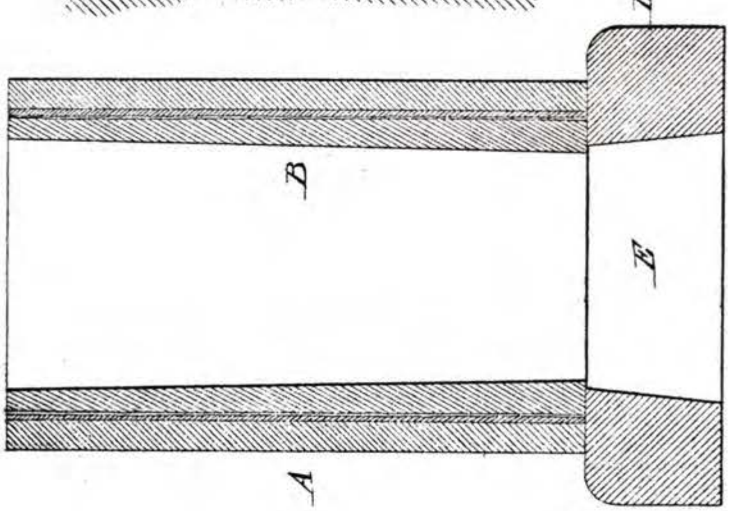


Fig. 3



**Witnesses:**

Jas. F. Coleman

Jno Robt Taylor

**Inventor**

Thomas A Edison

by Dyer Edmonds & Dyer,

Att'ys.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PROCESS OF DUPLICATING PHONOGRAMS.

**SPECIFICATION** forming part of Letters Patent No. 713,209, dated November 11, 1902.

Application filed March 5, 1898. Serial No. 672,650. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Processes of Duplicating Phonograms, (Case No. 994,) of which the following is a specification.

The object I have in view is to produce a practical process for the duplication of phonographic records, whereby a practically unlimited number of duplicate phonographic records may be obtained which will be absolutely identical in every respect with the original record. Generally I propose to construct a suitable matrix, preferably in metal, and by its use to impress duplicate phonograms with a phonographic record thereon, such phonograms being preferably constructed of a material having a greater coefficient of expansion than the material of the matrix or mold.

By my process the duplicate phonogram or the surface thereof may be and preferably is constructed of a material too hard for the satisfactory cutting of an original record therein by the usual phonographic recorder, whereby the duplicate phonograms may be made more durable than it is possible to make original records; but the duplicate phonograms may obviously be made of a softer material.

My improved process can be carried out for the reproduction of phonographic records of any desired form, either flat disks or hollow cylinders; but it has been specially devised for use in connection with the duplication of records of the latter type. For the duplication of cylindrical phonographic records from a tubular matrix my improved process also provides for the effective removal of the finished duplicate from the matrix without injury to the record-surface of the former.

In carrying my process into effect I first construct a matrix carrying a negative representation of the record, which matrix can be produced by any of the known processes—as, for example, those indicated in my Patent No. 484,582, dated October 18, 1892. As I explained in this patent, an original phonographic record having a surface of the usual wax-like material is first secured and its surface coated with a coating of conducting material in order to permit the original record to be electroplated. This conducting coating can be and preferably is applied by a process of vacuous deposit, as I described in my Patent No. 527,147, dated September 18, 1894, by placing the record in a vacuum-chamber in which a metal is vaporized by an electric arc produced between electrodes of the metal, the metallic vapor depositing as a thin uniform coating on the original record. I prefer to apply a preliminary coating by a process of vacuous deposit, for the reason that the highly-comminuted condition of the vaporized metal permits the coating to form as a uniform film, following accurately all the variations of the record, however minute. Instead of coating the original record with a vaporized metal it may be coated with a very thin layer of specially-prepared plumbago of exceedingly-great fineness, or instead thereof gold-leaf or silver salts reduced by chemical reagents to the metallic state may be used for the same purpose. Having thus applied a very thin preliminary coating to the original record, the latter is immersed in an electroplating bath and electroplated with a metal to the desired thickness, thereby forming a shell inclosing the original record, which shell carries on its bore an accurate negative representation of that record. Preferably this shell is suitably incased in a close-fitting cylindrical jacket, although if the electroplating is carried on long enough to form an electroplated coating of sufficient thickness a jacket need not be used. The original record is removed from the electroplated matrix obtained as described either before or after the jacket, if used, is applied to the shell. This removal of the original record can be effected either by dissolving or melting the wax-like material or by contracting the original record radially and removing it by a direct longitudinal movement. In the case of cylindrical phonographic records the resulting matrix will be a hollow metal cylinder or tube or one internally faced with metal carrying the phonographic record in relief upon its inner surface.

While I have indicated convenient and well-known methods for producing the matrix, it will be obvious that the matrix can be obtained in any other way familiar to those skilled in the art.

Having obtained a suitable matrix carrying a negative representation of the original phonographic record to be duplicated, I proceed with the duplication of the records as follows: The blanks which are to receive the duplicate records are preferably composed of a material having a higher coefficient of expansion than that of the matrix or mold, and said blanks are made sufficiently thick to maintain their shape during and after the act of disengagement from the matrix, as will be explained. The blank under normal temperatures is of a diameter very slightly less than the bore of the matrix or mold, whereby the blank may be inserted in the same. After the blank has been thus placed within the matrix or mold both the matrix and the blank contained therein are, or the blank alone is, brought to a higher temperature, whereby the blank will expand and will be brought into intimate contact with the record-surface of the matrix or mold, whereby the negative record thereof will be impressed with absolute accuracy upon the surface of the blank. The expansion of the blank into this intimate engagement with the interior of the matrix or mold may be effected in any suitable way, such as by maintaining the matrix or mold, with the blank contained therein, in a heated atmosphere. By making the blank of a material having a higher coefficient of expansion than the matrix or mold the blank will be properly expanded to receive the impression of the record, notwithstanding the fact that both the blank and the matrix or mold may be subjected to the same temperature.

In order to facilitate the operation and make the resulting duplicate record somewhat sharper, I prefer to introduce a tapering mandrel within the blank after the blank has been placed in the matrix or mold and heat applied to the blank, as explained, and to force the mandrel tightly within the blank after the latter has been expanded into engagement with the record, whereby the blank will be further expanded mechanically into absolute intimacy with the record, after which the mandrel will be immediately withdrawn. With blanks made of sufficiently viscous material the entire expansion may be effected mechanically by forcing a tapering mandrel within the same.

After the blank has been expanded, so as to receive the impression of the matrix or mold, it is removed by first shrinking it radially in any suitable way, as in a refrigerating-chamber, and by then withdrawing the resulting duplicate record by a direct longitudinal movement. Owing to the shallowness of the phonographic-record groove this radial shrinkage of the duplicate record effects a sufficient separation of the surfaces of the matrix and of the duplicate record to prevent injury to the surface of the duplicate record due to any longitudinal contraction thereof.

I find that by the process above described, and particularly when a matrix or mold is obtained by a process of vacuous deposit, as explained, duplicate phonographic records can be obtained which will be accurate reproductions of the original records and be free from extraneous noises and wherein the quality and intensity of the original vibrations will be reproduced with absolute faithfulness. I find, moreover, that since by this process there is little or no wear upon the matrix or mold a practically unlimited number of duplicates may be obtained from a single matrix or mold.

The degree of heat necessary to properly expand the blank will depend largely upon the material of which the blank is formed and upon the closeness of fit of the blank when inserted within the matrix or mold. For the same reasons the extent of the reduction of temperature in chilling and shrinking the duplicate record will vary to a considerable extent.

The invention is illustrated in the accompanying drawings for convenience in connection with a cylindrical phonogram.

In the drawings, Figure 1 is a sectional view showing a matrix or mold with a blank introduced therein prior to the expansion of the blank into engagement with the record-surface of the matrix; Fig. $1^a$, a section through a part of the walls of the blank and matrix very greatly enlarged; Fig. 2, a view similar to Fig. 1, showing the blank expanded into engagement with the matrix and illustrating also a tapered mandrel forced into the blank; Fig. $2^a$, a view corresponding to Fig. $1^a$, showing a part of the walls of the matrix, blank, and mandrel of Fig. 2, very greatly enlarged; Fig. 3, a view corresponding to Figs. 1 and 2 with the tapered mandrel removed and illustrating the formed duplicate as having been contracted radially preparatory to being removed from the blank by a direct longitudinal movement; and Fig. $3^a$, a section, very greatly enlarged, corresponding to Figs. $1^a$ and $2^a$ and illustrating the relative relation between the duplicate and matrix prior to the removal of the former.

In the views corresponding parts are represented by the same letters of reference.

A represents the matrix or mold, carrying on its bore a negative representation of the record to be reproduced.

B represents the blank to be duplicated, which is preferably provided with a tapered bore, as is now common, and which is of sufficient thickness to maintain its shape during and after the act of disengagement from the matrix. This blank is turned down so that it may be inserted within the matrix or mold with a close fit, as shown in Figs. 1 and $1^a$. The blank to be duplicated may be and preferably is of a harder material than can be practically or satisfactorily engraved, indented, or cut by a phonographic recorder, whereby the duplicate phonographic records will be more durable than could be obtained in the first instance by the operation of a recording or indenting device actuated directly by the sound-waves. These blanks may therefore be made of a relatively hard material, such as asphalt, or of stearic acid or stearate of soda mixed with varying proportions of fine precipitates—such as chalk, slaked lime, or lampblack—or waxes or resins may be used, such as sealing-wax or shellac mixed with fine precipitates, like chalk, or polished ebonite, vulcanized hard rubber, or celluloid may be used, or glue may be employed either alone or mixed with precipitates, such as chalk.

C, Figs. 2 and $2^a$, represents a tapered mandrel, which may be inserted within the blank B.

D represents a support for the matrix or mold and for the blank within the same, said support having an opening E therein, whereby the mandrel C may be moved longitudinally within the blank.

In carrying out the process I first introduce the blank within the matrix with as close a fit as practical, as shown in Figs. 1 and $1^a$, after which the mandrel C is inserted within the blank. These parts are then subjected to heat, such as by being maintained in a heated atmosphere, whereby the blank will, by reason of its greater coefficient of expansion than the matrix or mold, be expanded into intimate contact with the record-surface of the latter, and an impression of such record will be accurately received on the blank. When the blank has been thus expanded into engagement with the matrix or mold, the mandrel C is forced tightly within the blank, so as to further expand it mechanically, whereby the blank will be forced into absolute intimacy with the record, and an impression will be received on the blank which will be clear, sharp, and an absolutely faithful reproduction of the original record. After the mandrel has been forced within the blank it is immediately withdrawn, and the blank is then chilled in any suitable way, such as by placing the matrix, with the blank contained therein, in a refrigerating-chamber. In this way the blank or duplicate will shrink or contract radially, as shown in Figs. 3 and $3^a$, sufficiently to be removed from the matrix or mold by a direct longitudinal movement. Owing to the extreme shallowness of the phonographic-record groove, a sufficient radial separation between the resulting duplicate and the matrix or mold will take place to prevent any longitudinal contraction of the duplicate from injuring the record-surface thereof.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. The process of duplicating sound-records that consists in impressing a plastic record-tablet against a suitable matrix by its own expansive force.

2. The method of producing hollow cylindrical phonograms, which consists in obtaining a mold having a reverse phonogram-record on the inner wall of a cylindrical opening, forming a hollow cylindrical plastic phonogram within said mold, releasing the phonogram from the mold by a radial contraction of the phonogram sufficient to entirely clear the surfaces, and removing the phonogram from the mold by direct longitudinal movement.

3. The method of producing hollow cylindrical phonograms which consists in obtaining a mold having a reverse phonogram-record on the inner wall of a cylindrical opening, forming a hollow cylindrical plastic phonogram within said mold, releasing the phonogram from the mold by a reduction in temperature sufficient to entirely clear the surfaces, and removing the phonogram from the mold by direct longitudinal movement.

4. The method of producing phonograph-cylinders which consists in placing within a hollow cylindrical record mold or matrix, a hollow cylindrical phonograph-blank of sufficient thickness to maintain its shape during and after its engagement with the matrix, outwardly expanding such blank against said matrix, disengaging the impressed record-cylinder from the matrix, and withdrawing said record-cylinder from the matrix by direct longitudinal movement.

5. The method of producing phonograms which consists in placing within a hollow cylindrical record-matrix a hollow cylindrical phonograph-blank of sufficient thickness to maintain its form under normal conditions, softening said blank by heat and expanding the same while heated so as to take the record from the matrix, shrinking the phonogram so made by change of temperature, and withdrawing the same from the matrix by direct longitudinal movement.

6. The method of producing phonograms which consists in placing within a hollow matrix a hollow body of plastic material, said body being a cylinder on its outer surface and having a tapering central longitudinal aperture, softening said body by heat and expanding it into the matrix by the longitudinal movement of a tapering plunger within the plastic body, shrinking the plastic material and withdrawing it from the matrix by direct longitudinal movement.

7. The process of duplicating phonograms having a phonographic record thereon, which consists in forming a matrix or mold wherein the original record will be reproduced in relief, in loosely engaging a blank phonogram with said matrix, and in finally intimately engaging the blank phonogram with said matrix or mold by changes in temperature, substantially as set forth.

8. The process of duplicating phonograms having a phonographic record thereon, which consists in depositing a metal on said phonogram to form a matrix or mold wherein the original record will be reproduced in relief, and in intimately engaging a blank phonogram with the said matrix or mold by a change in temperature, substantially as set forth.

9. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal on said phonogram to form a matrix or mold wherein the original record will be reproduced in relief, in inserting the continuous cylindrical blank to be reproduced within said matrix or mold, in expanding the blank into intimate engagement with the record in relief carried by the bore of said matrix or mold, the cylindrical blank being sufficiently thick to maintain its shape during and after the act of disengagement from the matrix, and finally removing the cylinder by direct longitudinal movement, substantially as set forth.

10. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal upon the original phonogram so as to form a matrix or mold, in inserting the blank to be reproduced within said matrix or mold, in expanding the blank into intimate engagement with the record in relief carried by the bore of said matrix or mold, in finally shrinking the blank to disengage it from the matrix or mold, the cylindrical blank being made sufficiently thick to maintain its shape during and after the act of disengagement from the matrix, and finally removing the cylinder by direct longitudinal movement, substantially as set forth.

11. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal on said phonogram to form a matrix or mold wherein the original record will be reproduced in relief, in inserting the blank to be reproduced within said matrix or mold, in heating the blank, whereby the same will be expanded into engagement with the record in relief carried by the bore of said matrix or mold, and in finally subjecting the expanded blank to pressure to more intimately engage it with said record, substantially as set forth.

12. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal on said phonogram to form a matrix or mold wherein the original record will be reproduced in relief, in inserting the blank to be reproduced within said matrix or mold, in heating the blank, whereby the same will be expanded into engagement with the record in relief carried by the bore of said matrix or mold, in subjecting the expanded blank to pressure to more intimately engage it with such record, and in finally chilling the blank to remove it from the matrix or mold, substantially as set forth.

13. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal upon the original phonogram to form a matrix or mold, in covering said matrix or mold with a metal backing, in introducing the continuous cylindrical phonogram to be reproduced within said matrix or mold, in expanding said phonogram into intimate engagement with the record in relief carried by the bore of said matrix or mold, the cylindrical blank being made sufficiently thick to maintain its shape during and after the act of disengagement from the matrix, and finally removing the cylinder by direct longitudinal movement, substantially as set forth.

14. The method of producing phonograms, which consists in securing a hollow metallic mold or shell containing the reverse record, placing in said mold an expansible blank sufficiently thick to maintain its shape during and after its removal from the mold, expanding both by heat, impressing the record in the blank, contracting the phonogram so made by the withdrawal of heat, and removing the phonogram from the mold by a direct longitudinal movement, substantially as set forth.

15. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal upon the original phonogram so as to form a matrix or mold, in inserting within said matrix or mold a blank to be reproduced made of a material having a higher coefficient of expansion than said matrix or mold, and in heating the blank and matrix carried thereby, whereby the blank will be expanded into intimate engagement with the record in relief carried by the bore of said matrix or mold, substantially as set forth.

16. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing in a vacuum a metal vapor upon the original phonogram, electroplating a metal thereon so as to form a matrix or mold, in inserting the continuous cylindrical blank to be reproduced within said matrix or mold, in expanding the blank into intimate engagement with the record in relief carried by the bore of said matrix or mold, the cylindrical blank being made sufficiently thick to maintain its shape during and after the act of disengagement from the matrix, and finally removing the cylinder by direct longitudinal movement, substantially as set forth.

17. The method of producing record-cylinders for phonographs, which consists in first forming a record on a cylinder of wax or other relatively soft material, rendering the surface of the wax cylinder electrically conductive, and electrolytically depositing metal thereon forming a matrix, and then outwardly

expanding under pressure within the matrix a cylinder or tube of softened material sufficiently thick to maintain its shape during and after the act of disengagement from the matrix, and finally removing the cylinder or tube by direct longitudinal movement.

18. The herein-described process of molding sound-records in celluloid, which consists of softening a celluloid tablet and then forcing the same against a suitable matrix by its own expansive force, substantially as described.

This specification signed and witnessed this 21st day of February, 1898.

THOMAS A. EDISON.

Witnesses:
J. F. RANDOLPH,
RICHD. N. DYER.

No. 727,960. PATENTED MAY 12, 1903.

J. W. JONES.

SOUND RECORDING TABLET.

APPLICATION FILED MAR. 27, 1900.

NO MODEL.

*Fig. 1.*

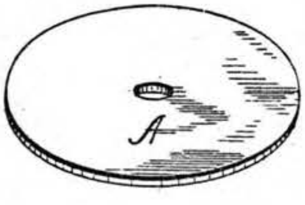


*Fig. 2.*

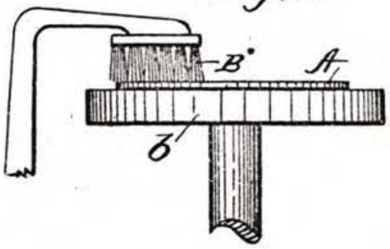


*Fig. 3.*

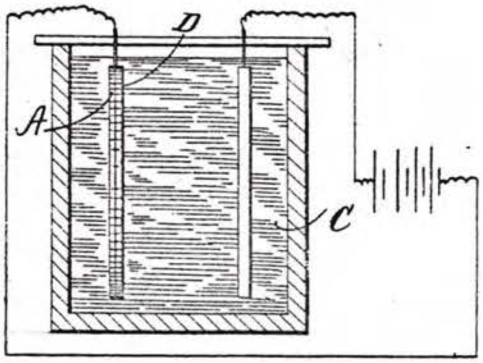
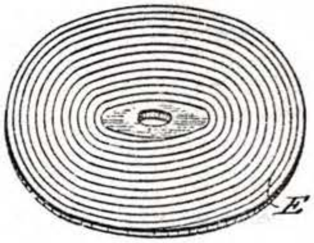


*Fig. 5.*



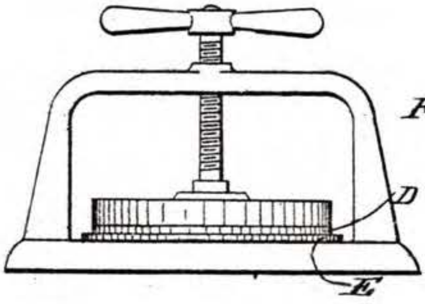


*Fig. 4.*

Witnesses.
W. R. Edelen.
W. B. [illegible]

Inventor
Joseph W. Jones
by Philipp Mauro
his attorney.

# UNITED STATES PATENT OFFICE.

JOSEPH W. JONES, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN GRAPHOPHONE COMPANY, OF WASHINGTON, DISTRICT OF COLUMBIA, A CORPORATION OF WEST VIRGINIA.

## SOUND-RECORDING TABLET.

**SPECIFICATION** forming part of Letters Patent No. 727,960, dated May 12, 1903.

Application filed March 27, 1900. Serial No. 10,367. (No specimens.)

*To all whom it may concern:*

Be it known that I, JOSEPH W. JONES, of the city and State of New York, have invented new and useful Improvements in Sound-Recording Tablets, which are fully set forth in the following specification.

Sound-records of the type characterized by vertical irregularities corresponding to sound-waves (commonly known as "graphophone" or "phonograph" records) are engraved in a wax-like material and may be employed directly for purposes of reproduction. Copies or duplicates are obtained from such originals by the well-known mechanical process of duplicating by means of a "duplicating-machine." These duplicates also are engraved, and the material in which they are formed is no harder or more durable than the original recording material. The making of each such duplicate defaces the original more or less, so that the duplicates get poorer and poorer, while the original is soon worn down. On the other hand, sound-records characterized by lateral undulations (the type being commonly known as "gramophone-records") are produced by tracing a line in a film deposited on a plate and are incapable of direct reproduction. At present the tracing so obtained is etched into the plate by an acid, and from the grooved plate thus produced is obtained an electroplate for stamping out the commercial record. This method of producing commercial records has certain defects, so that the copies thus produced are not correct representations of the path of the recording-stylus. In an earlier application (No. 659,170, filed November 19, 1897) I have described an improved method of producing commercial records of this type which are faithful copies of the original. This method consists, briefly, in making the original record-groove of full depth in the first instance, thus avoiding the necessity of etching, next coating the record with a conducting medium, then electroplating, and finally pressing this electroplate matrix into the material to be stamped.

My present invention is broader, applying to records of both the types referred to and comprising the new sound-recording tablet constituting the subject-matter claimed herein and the process claimed in divisional application, Serial No. 113,327, filed January 26, 1902. Briefly stated, said process consists in making the original record-groove of full size in or upon a surface suitable for recording and which at the same time is itself an electrical conductor, then electroplating the record-surface, and finally using the matrix so obtained as a die or stamp.

To produce the new recording-tablet, I first take any substance that has sufficient body or cohesion to withstand the electroplating and retain its form, while at the same time it must be capable of receiving a record—that is, be readily removable by the recording-stylus with as little resistance as possible. As the original record is not used for reproducing sounds directly, (as in case of graphophone-records,) it need not be near so hard as graphophone blanks. This material may be designated as "wax-like," which term will be used in this application to indicate any plastic material suitable for the purpose that is of sufficient body without offering too much resistance. This wax-like material is then prepared for use by impregnation with some electric conductor, hereinafter called simply a "conductor." As an example, I may take ordinary beeswax and add a little rosin to harden it slightly and then impregnate the mixture with graphite or other suitable conductor. As only that portion of the recording material which will be exposed to the action of the electric bath need be a conducting medium, the graphite (or other conductor) may be impregnated throughout the bulk or body of the material merely to a slight depth beneath the surface, or, in other words, to or slightly below the depth of the sound-groove to be formed therein. The proportion of conducting material employed may be varied according to circumstances, depending upon the character of the ingredients and the kind of conductor employed. The recording material is now shaped into tablets or disks for use. Better effects are obtained by burnishing the surface of the disk before recording.

This gives the surface a beautiful smooth polish and spreads out the particles of graphite (or other conductor) over the recording-surface so as to produce a perfect conducting-surface.

In using the herein-claimed sound-recording tablet in accordance with the process of my said divisional application said tablet is placed upon a suitable sound-recording machine, and the sound-record is made in or upon the surface of the tablet. The grooves are made once for all of full depth and size and require no deepening or enlarging by an etching fluid or otherwise. The record-groove may be either of the vertically-undulated (graphophone) type or of the laterally-undulated (gramophone) type. This finished original record is placed in an electric bath, while a coating or plate of metal, as copper, is deposited thereon by electrolysis. The electroplate and the original are then separated, and the latter may be used repeatedly in the same manner. The electroplate matrix contains a faithful counterpart in reverse of the irregularities constituting the original record of sound. It is pressed into any suitable material that when treated is comparatively yielding (as compared with the matrix) but that is (or becomes) sufficiently hard to retain its shape and withstand reproduction and handling. Electrose and other fibrous substances are particularly suited for this purpose.

It will be observed that by my improved process I can produce from the original record any number of matrices that may be used to multiply indestructible copies or duplicates, that I avoid the aberrations due to the etching process and the blurrings caused by depositing a conductor upon a record already formed, and that the matrices produced by this improved method are absolutely faithful counterparts of the original and the commercial records for that reason better.

In the drawings annexed hereto to illustrate this invention, Figure 1 shows a recording-tablet A, being a wax-like mixture impregnated with a conducting medium. Fig. 2 shows tablet A being burnished, as by a brush B, the tablet being on a rotating wheel *b*. Fig. 3 shows the tablet after having the sound-record cut thereon as suspended in the electroplating-bath C. Fig. 4 shows the electroplate-die D being pressed into a disk E of fibrous material, and Fig. 5 shows the completed commercial record E.

Having thus described my invention, I claim—

1. A sound-recording tablet made of a material electrically conductive throughout its bulk or body and of such normal consistency as to be acted upon by a recording-stylus actuated by sound-waves in the act of forming a sound-record.

2. A sound-recording tablet composed of a material electrically conductive throughout its bulk or body, of such normal consistency as to be acted upon by a recording-stylus actuated by sound-waves in the act of forming a sound-record, and having its surface burnished.

3. A sound-recording tablet made of wax or wax-like material impregnated throughout its bulk or body with an electrically-conducting material and of such normal consistency as to be acted upon by a recording-stylus actuated by sound-waves in the act of forming a sound-record.

4. A sound-recording tablet made of wax or wax-like material impregnated throughout its bulk or body with an electrically-conducting material in a finely-divided state and of such normal consistency as to be acted upon by a recording-stylus actuated by sound-waves in the act of forming a sound-record.

5. A sound-recording tablet composed of wax or wax-like material impregnated throughout its bulk or body with graphite, and of such normal consistency as to be acted upon by a recording-stylus actuated by sound-waves in the act of forming a sound-record.

6. A tablet for receiving a record of sound, consisting of a non-conductive substance impregnated with a conducting substance the mixture being of such normal consistency as to enable a sound-record to be formed therein by a recording-stylus actuated by sound-waves.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

JOSEPH W. JONES.

Witnesses:
C. A. L. MASSIE,
ELISHA K. CAMP.

## Dodd Deposition.

IN AMERICAN GRAPHOPHONE COMPANY *vs* NATIONAL PHONOGRAPH COMPANY.
March Term, 1906,
In Equity,
No. 11.

January 9th, 1906.

Met pursuant to agreement.

Present—PHILIP MAURO, ESQ., for Complainant; FRANK L. DYER, ESQ., for Defendant.

DAVID A. DODD, a witness on behalf of defendant, having been first duly sworn, testifies in answer to questions by Mr. Dyer, as follows:

DIRECT EXAMINATION, by MR. DYER:

*Q.* 1. Give your name, age, residence and occupation?

*A.* David A. Dodd; age, 44; residence, 273 Dodd Street, East Orange; occupation, foreman in charge of the wax-making department of the Edison Phonograph Works.

*Q.* 2. What is this wax used for?

*A.* Making blanks and records also.

*Q.* 3. How long have you had charge of this wax?

*A.* Since May, 1897.

*Q.* 4. How did you happen to be put in charge of this work?

*A.* Mr. Aschenger was in charge, and he imagined the fumes from the wax was injuring his health (he told me that personally) and sent his resignation in to Mr. Gilmore. Mr. Gilmore put me in charge in his place.

*Q.* 5. Were you employed by the Edison Phonograph Works prior to the time you took Mr. Aschenger's place? *A.* Yes, sir.

*Q.* 6. In what capacity?

*A.* I was employed in the nickel-plating department prior to that.

*Q.* 7. How long had you been in charge of the nickel-plating department? *A.* From May, 1890—just seven years.

*Q.* 8. Did Mr. Aschenger explain the manufacture of the wax composition to you before he left? *A.* He did.

*Q.* 9. How long did it take you to understand this manufacturing operation?

*A.* I took hold of it immediately, Mr. Aschenger being with me about one week.

*Q.* 10. Is the blank composition now made by the Edison Phonograph Works under your direction, of the same formula, and is it made by the same process as explained to you by Mr. Aschenger? *A.* It is.

*Q.* 11. Have you made this composition continuously since May, 1897? *A.* I have.

*Q.* 12. In small amounts or in large amounts?

*A.* In large amounts.

*Q.* 13. Please put on the record the wax composition given you by Mr. Aschenger in May, 1897, and which you say has been continuously used since then?

*A.* I am not prepared to do this now, but I will get Mr. Aschenger's formula and produce it at the next session.

*Q.* 14. Can you state the different ingredients that you have used in the composition since May, 1897?

*A.* We use in our composition of wax, stearic acid, ceresin, metallic aluminum, caustic soda, and sal-soda.

*Q.* 15. Have you always used these ingredients?

*A.* I have.

*Q.* 16. Without reference to the particular amounts of the several ingredients used, please describe the process for making the wax, as carried out by you in 1897?

*A.* First, our solution was made up, using caustic soda, aluminum and water; after this was brought to a boil until the metal is all dissolved, then the carbonate of soda, or sal-soda, is added to this solution. After this is thoroughly dissolved, it is passed through a filter; this filtered solution is now ready to be added to the stearic acid that has been melted and to a temperature of about 280 degrees F., adding a ladle full at a time. As the solution is added to the stearic acid, the heat has to be gradually raised to the kettle of wax in the progress of making. When the solution is all in, the temperature of the wax should be about 430 degrees F., at which temperature it should remain until it is thoroughly foamed off. The wax is passed through a filter and is ready to manufacture our blanks of.

*Q.* 17. You spoke of ceresin as one of the ingredients in the composition. When is this material added?

*A.* After the solution is all in. I neglected to state that.

*Q.* 18. What is the purpose of adding the solution slowly?

*A.* It would cause our kettle to foam over if we added a large quantity at a time.

*Q.* 19. What is the purpose of raising the temperature of the composition to about 430 degrees F.?

*A.* We gradually raise the temperature up to that because as we gradually add the solution the melting point of the wax becomes higher, consequently we have to raise the heat on the wax to a higher temperature.

*Q.* 20. You spoke of the operation of "foaming off." How long is this maintained?

*A.* For about two and a half to three hours.

*Q.* 21. Dependent on what?

*A.* On the foam which still remains on the top of the wax. The heat drives all moisture from the kettle.

*Q.* 22. Is the process you have described the one that you have used continuously since May, 1897?

*A.* With the exception of making our solution. Instead of solving the metal in the caustic in water, I also add the carbonate at the same time.

*Q.* 23. Then, as I understand it, in May, 1897, you added the sal-soda at some other stage of the operation than in the formation of the solution?

*A.* No, that is not it. I started to make the solution, dissolving the metal in the caustic, and after thoroughly dissolved, adding sal-soda to the solution, obtaining the same results by either process.

*Q.* 24. Can you put on the record the wax formula as you now use it at the present time?

*A.* I can. Our composition that we use for making the wax at the present time is composed of 850 lbs. of stearic acid, 173 lbs. ceresin. The ingredients for making the solution are 1487 grams of sheet aluminum, 3842 grams of caustic soda and 153 lbs. of sal-soda.

*Q.* 25. Is it your present recollection that these proportions of ingredients differ materially from the formula explained to you by Mr. Aschenger in May, 1897?

*A.* It does not, very little changes being made, if any.

Adjourned subject to agreement.

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Sept. 28, 1906.

The examination of Mr. DODD is continued by Mr. DYER.

*Q.* 26. Do I understand that when you took charge of the wax manufacture in May, 1897, Mr. Aschenger gave you written instructions concerning the formula and manner of making the wax?

*A.* He did not give me the formula, but dictated the same, and I wrote it down.

*Q*. 27. Can you produce your original note made at Mr. Aschenger's dictation?

*A*. I cannot, but I can give you a copy of the same.

*Q*. 28. What became of the original note?

*A*. The original I had in a small pass book, and after keeping it for several years, made a copy of it in another book, before destroying the old book.

*Q*. 29. Please produce the copy of the original note and read the same on the record?

Objected to as incompetent.

*A*. "Aluminate of soda solution, quantity to every 100 lbs., Stearic acid.

22–1/2 lbs. Sal-soda.
458 Grams Caustic Soda.
175 " Aluminum Metalic.

4 gals. water. For one batch, three times the quantity of the above chemicals. Heat 300 lbs. Stearic Acid to 280° Fahrenheit, then add carefully the Aluminate of Soda solution, about ½ gal. at a time, after all the solution is mixed in, raise the heat to 430° Fahrenheit, let the above foam off, then add 50 lbs. Ceresin cakes, raise the heat to 430° Fahrenheit, and filter through canvas."

CROSS-EXAMINATION, by Mr. MASSIE.

*xQ*. 30. As foreman in charge of the wax making department of the Edison Phonograph Works, do you make wax for masters, for blanks, and for molding records too? *A*. I do.

*xQ*. 31. Do you make the same composition for masters and for blanks *A*. I do.

*xQ*. 32. How is the composition different from the composition for the molded record?

> The question is objected to and the witness is instructed that he is not called upon to divulge factory operations which he may be now practicing. For the purposes of this case, it was admitted by defendant that subsequent to the grant of the patent in suit and prior to the filing of the bill herein, defendant made use of a composition disclosed in patent to Aylsworth, No. 782,375.
>
> Furthermore, the witness had not testified on direct examination concerning the manufacture of molded record composition, and the question is therefore additionally objected to as incompetent, immaterial and

irrelevant. The witness is instructed that he is not called upon to answer the question.

*A.* I decline to answer.

*xQ.* 33. Confining yourself for the present to the period between June 13, 1898 (the date of the patent in suit) and April 1, 1905 (the date of the bill) in what respects did the composition for molded records differ from the composition of masters and blanks.

Objected to as incompetent, irrelevant and immaterial.

*A.* There was practically no difference, other than adding other materials, such as carnauba wax, to harden our composition and a black pigment, such as lamp black, to color it.

*xQ.* 34. How do you fix the date of your taking charge of the wax making department of the Edison Phonograph Works?

*A.* From memory, knowing that I left the nickel-plating department at that date to take charge of the wax-making department.

*xQ.* 35. During the period inquired of in *xQ.* 33 did you make use of the same methods, temperatures, etc., in making the wax compositions for these three different purposes?

*A.* They are all treated the same way.

*xQ.* 36. We will for the present confine ourselves to the composition for blanks and masters. I understand that you first employed a temperature of about 280° F. and subsequently ran the heat up to the higher temperatures. Was the composition at the lower temperature in a perfectly limpid state?

*A.* When the stearic acid was melted, the temperature was about 280° F. at which point it was perfectly limpid. As the solution was added, the melting point was gradually raised, so that the temperature was increased gradually up to 430° F. It would be possible to add the solution by not raising the temperature above 280° but it would be very slow indeed, owing to the fact that the water would be driven off very slowly.

*xQ.* 37. Did you make the blank cylinders? *A.* I did.

*xQ.* 38. These blanks were then shaved down to the finished article to be sold either for blanks or to constitute masters, were they not? *A.* They were.

*xQ.* 39. Did you have charge of this work? *A.* I did.

*xQ.* 40. Was there any difficulty in casting the blanks?

*A.* There was not.

*xQ.* 41. Was there any difficulty in getting the blanks out of the mold? *A.* There was not.

*xQ.* 42. In trimming down the blanks, did you observe whether or not they had a smooth uniform structure, such as to suit them perfectly for receiving the record? *A.* Yes.

*xQ.* 43. Are you able to state whether in these respects they were inferior to the composition made during the same period for molded records?

Objected to as incompetent, irrelevant and immaterial.

*A.* If anything, more smooth.

*xQ.* 44. Who was the person who regulated the heat to be employed, I mean the person who observed the thermometer and actually knew what the temperature was?

*A.* The man in charge of the kettle of wax in the progress of making.

Signature and certificate waived.

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## Thornberry Report.

EDWARD D. EASTON, PRESIDENT AND GEN'L MANAGER.
GEO. W. LYLE, VICE-PRESIDENT.
C. W. COX, TREASURER.

DIRECTORS:
GEO. W. LYLE,
ANDREW DEVINE,
F. J. WARBURTON,
EDWARD D. EASTON,
WM. E. BOND,
THOS. R. WHITE, JR.,
PHILIP MAURO,
JOHN J. PHELPS,
MARK T. COX,
PAUL H. CROMELIN,
WILLIAM M. JOHNSON,
D. C. M'EWEN,
E. V. MURPHY,
OGDEN MILLS.

AMERICAN GRAPHOPHONE COMPANY.
Factory: Bridgeport, Conn.
T. H. Macdonald, Manager.

Sept. 4, 1906.

MR. MACDONALD:—

Attached herewith you will find reports from the several gentlemen, who either witnessed the operations as performed by the writer or else did the work themselves.

Records from the following formulæ, were made, viz:—formula #A, Patent of 1898, with temperature called for in Patent of 1899: to be known as #3. Formula #B, Patent of 1898, with temperature called for in Patent of 1899: to be known as #6. Formula #A, with temperature called for in Patent of 1899, with the addition of Carnauba, the amount specified by the table of Mr. Aylesworth: to be known as #2. Formula #B, with temperature called for in Patent of 1899, with the addition

Raymond R. Wile Research Library

of Carnauba, the amount specified by the table of Mr. Aylesworth; to be known as #5.

The materials in the above formulæ were weighed and placed in the cooking kettles by the writer. A constant temperature of 450° F was maintained during the cooking, which lasted for sixteen hours. The mixtures were then filtered and transferred to other kettles, where records were dipped. During the process of dipping, a constant temperature of 410° F was maintained in every case. No difference, between the Wax of the several formulæ, could be detected during the processes of cooking, dipping, and cooling while the Wax was in the moulds.

The records were then taken to the Chemical Laboratory put in cartons, and then delivered to Mr. Macdonald by the writer. One record from each formula was put on a BF electric machine running at 160 revolutions per minute, the average speed of any cylinder machine. Spring Reproducers were used and a wear test was made. A similar wear test was made on two regular Columbia records, to be known as records number 1 and 4. These last two records were made from the same Masters as the records in question.

At the end of every fifty reproductions, these records were submitted to Messrs. Belcher, Capron and Osborne. These gentlemen have been employed by the American Graphophone Company something over seven years, and are competent judges as to the surface and wearing qualities of any record. At the end of the 175th reproduction of these records, the 3rd and 6th record were worn out entirely. At the end of the 200th reproduction, the 2nd and 5th records were worn out entirely. Showing that the only effect, produced by the addition of Carnauba, is to harden the wax and increase the wearing quality of the record.

F. L. THORNBERRY.

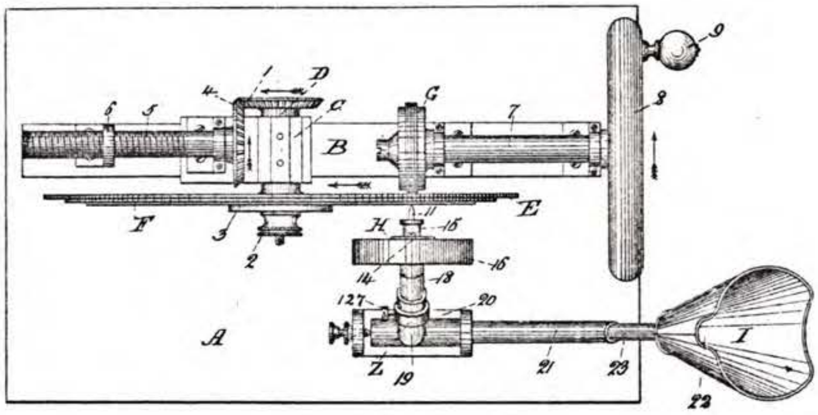
(No Model.) 4 Sheets—Sheet 1.

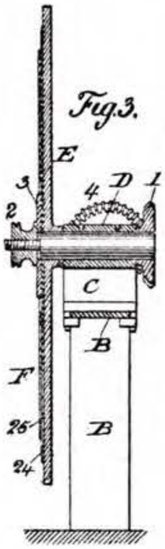
# C. A. BELL & S. TAINTER.

## RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig. 1.





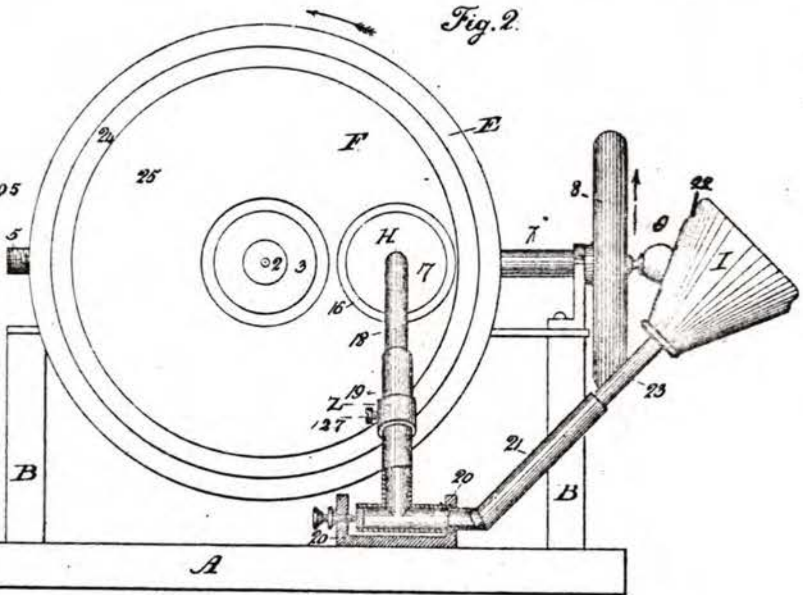


Fig 4.

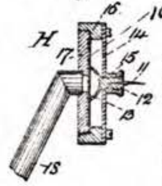


Fig 5.

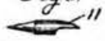


Fig 6.

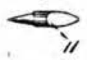


Fig. 9.

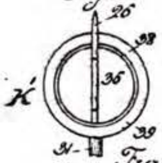


Fig. 8.

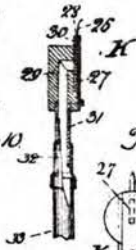


Fig 10.

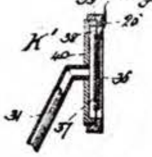


Fig. 7.

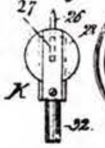
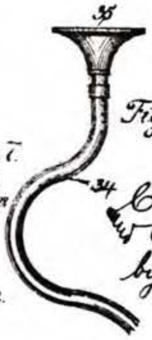


Fig 11.



Witnesses.
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Inventors.
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and Sumner Tainter
by A. Pollok
their attorney

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# C. A. BELL & S. TAINTER.

## RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig. 12.

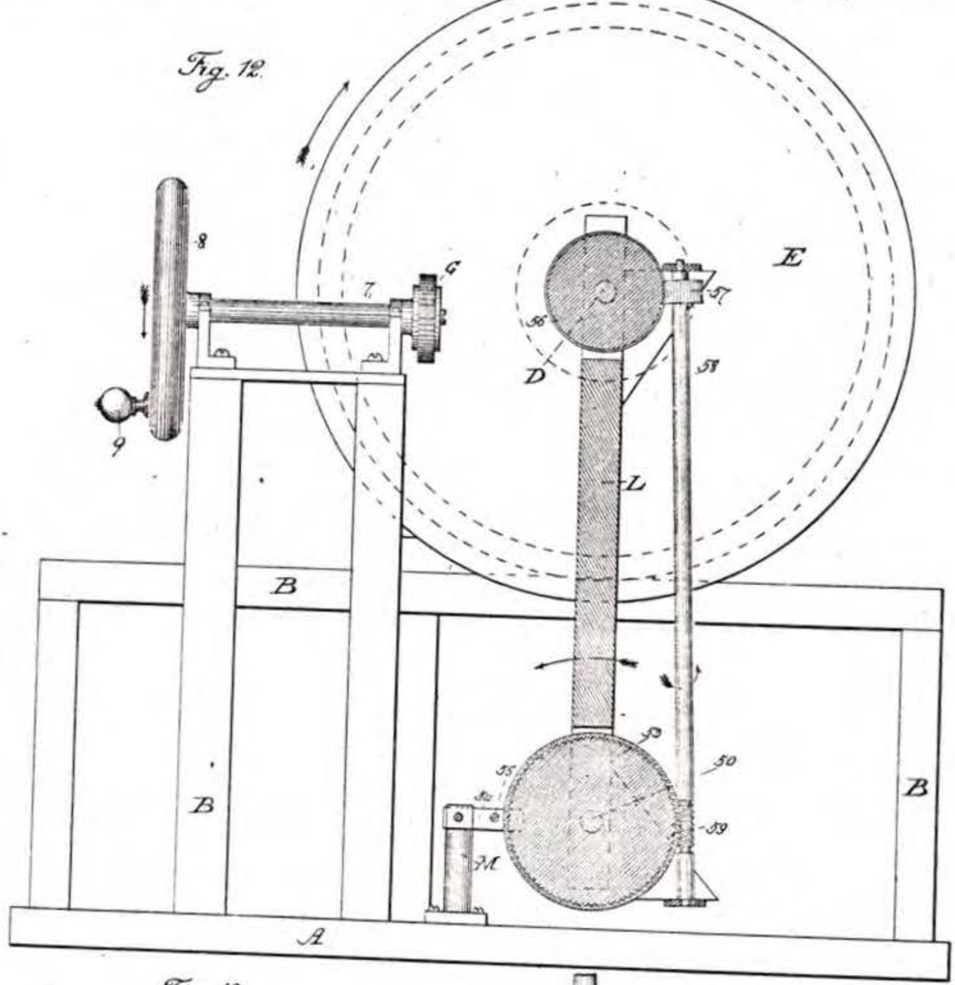
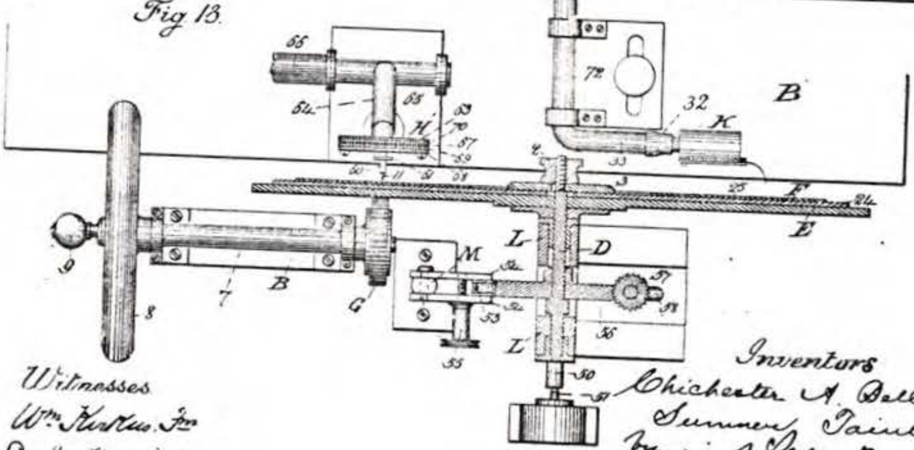


Fig 13.



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# C. A. BELL & S. TAINTER.

## RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig 14.

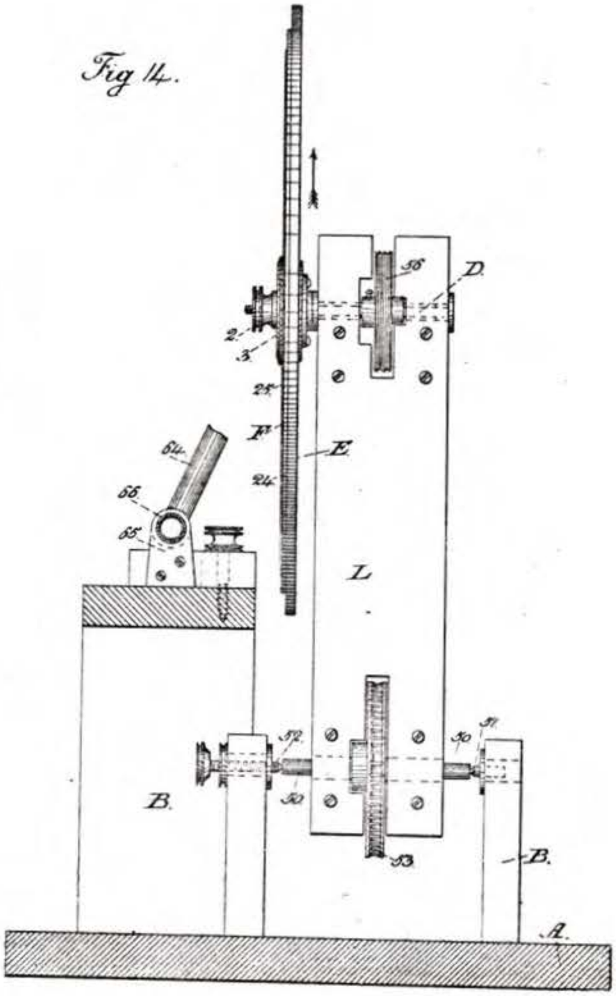


Fig. 21.

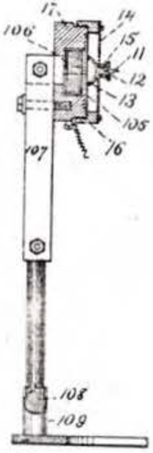


Fig. 15.

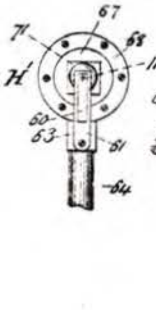


Fig 16.

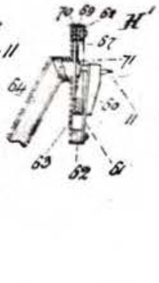
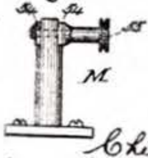


Fig 17.



Witnesses

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# C. A. BELL & S. TAINTER.

## RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig 18.

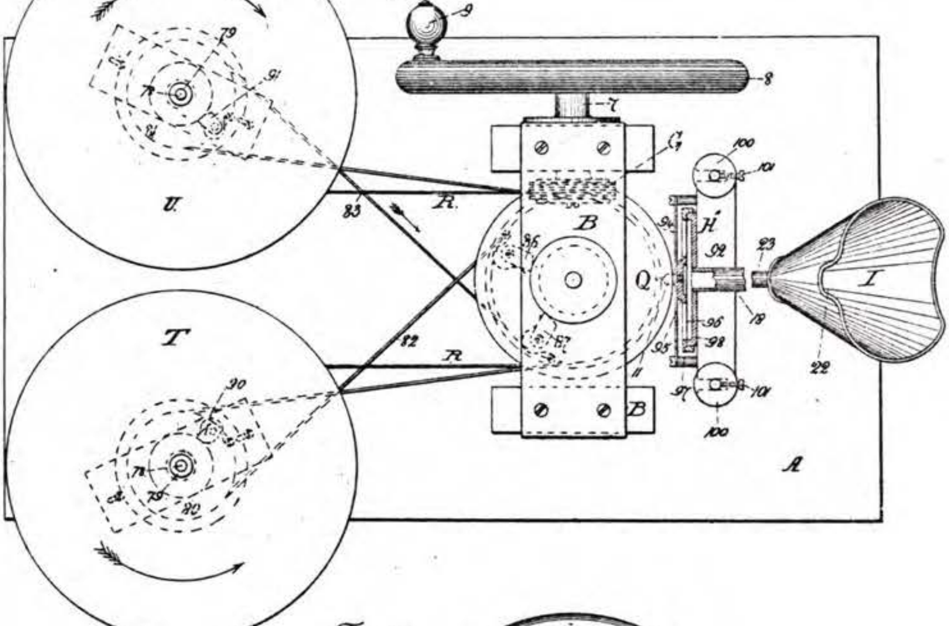


Fig 19.

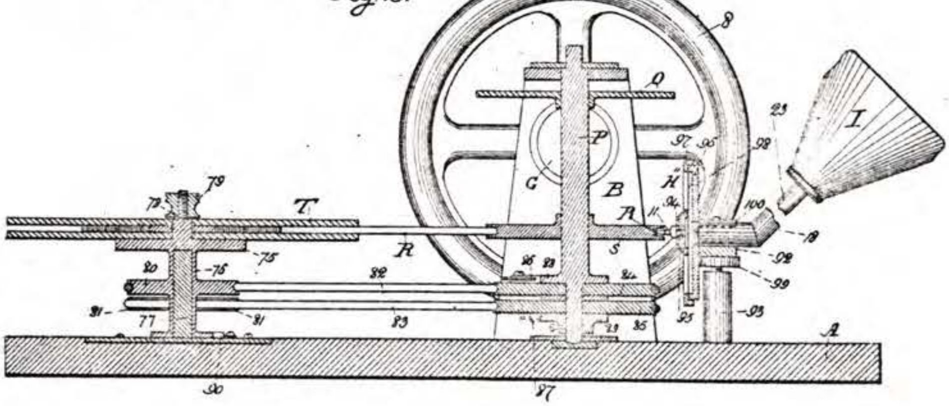
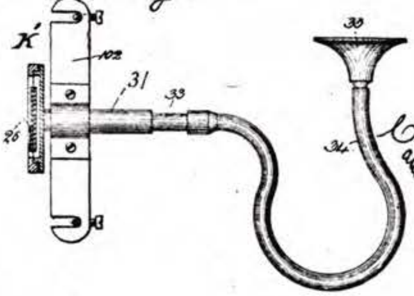


Fig 20.



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Inventors.
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by A. Pollok
their attorney

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

CHICHESTER A. BELL AND SUMNER TAINTER, OF WASHINGTON, D. C.

## RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

SPECIFICATION forming part of Letters Patent No. 341,214, dated May 4, 1886.

Application filed June 27, 1885. Serial No. 170,044. (No model.)

*To all whom it may concern:*

Be it known that we, CHICHESTER A. BELL and SUMNER TAINTER, both of Washington, in the District of Columbia, have invented a new and useful Improvement in Recording and Reproducing Speech and other Sounds, which improvement is fully set forth in the following specification.

This invention relates to the formation, in a solid substance, of elevations and depressions, or other inequalities corresponding more or less perfectly to the forms of sound-vibrations, and the reproduction, by means of such inequalities, of the sounds represented by them.

The invention consists, first, in the formation of the record or "phonogram," as it has been called, by means of a cutting-style which is vibrated by the sound-waves or sonorous vibrations to be recorded. The vibrations may be impressed upon the style directly by the impact of the sound-waves upon some device mechanically connected with or carried by the cutting-style or its support, or indirectly through the action of an electric current or other suitable vibratory medium. Heretofore a large number of contrivances have been devised for converting electrical impulses into mechanical vibrations, and they could, of course, be used for vibrating the cutting-style. Otherwise they have no relation to this part of the present invention, the essential new feature of which is the removal of material to form the record by a cutting, gouging, or graving action of the vibrating style. Heretofore the vibrating style has, as in Edison's well-known phonograph, simply indented the recording material. It has been proposed to cut the record in the edge of a strip of metal or other solid material by vibrating the strip in contact with the cutting edge of a rotary disk cutter; but this proposal is essentially different from this invention, the new mode being applicable to cutting the record upon all sorts of surfaces, and not upon strips only, and is, besides, believed to be later in time than this invention. Under this part of the invention are included the vibratory cutting-style as a new device in a sound-recorder, and the combination of the same with other devices; also the cut or engraved record itself. In this new or improved form of record not only may a larger number of words or sounds be recorded in a given surface than has been practicable with the indented records heretofore in use, but the recorded vibrations are also sharper and better defined. It is found that an indenting style smooths over the crests of the larger elevations, and also rubs out some of the finer ones.

The invention consists, secondly, in engraving or cutting the record in a waxy or amorphous, and slightly cohesive substance. Preferably, a compound of beeswax and paraffine (the latter in excess) is employed. This compound has no tendency to clog the style, but is readily removed thereby in chips or shavings. This part of the invention also consists in a recording material composed of a wax or waxy surface on a paper or pasteboard foundation. Heretofore it has been proposed to use soft paper saturated or coated with paraffine as the material for recording by the indenting method; but its use does not appear to have been successful, and an outer layer of tin-foil was therefore employed to receive the indentations.

The invention consists, thirdly, in cutting or engraving the record in the form of a groove with sloping walls, the sound-waves being represented by elevations and depressions at the bottom of the groove or otherwise. The advantage of this form of record is that it forms an efficient guide to the reproducing-style.

The invention consists, fourthly, in loosely mounting the reproducing-style so that it can readily be guided by the record. Preferably the reproducing-style, or rather what may be called the "head" of the reproducing instrument is mounted on an universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight. Practically in the instruments made by us the pressure is due to the weight of the instrument, modified by the elasticity of a section of soft-rubber tube, which supports the same and constitutes a universal joint; but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound record or phonogram, and which, therefore, would be within the spirit of the invention. The reproducing-style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record.

The invention consists, fifthly, in reproducing directly from the wax record. It is found that such a record has sufficient strength to withstand the rubbing action of the reproducing-style, so that a considerable number of reproductions can be obtained from it. The smoothness of the wax gives it a great advantage in this regard. So far as we are aware, no one has reproduced sounds from a wax record by rubbing a style or reproducer over it.

The invention consists, sixthly, in a reproducer or reproducing instrument in which the reproducing-style, instead of being placed behind its support, projects at the point beyond the edge thereof. One practical advantage of this is that it enables the position of the style on the record or phonogram readily to be observed.

The invention consists, seventhly, in cutting the sound-record in a fusible material, (the waxy compound before referred to, for example,) and then melting the surface slightly, so as to remove any roughness left by the cutting-style. These roughnesses are altogether outside of the sound-vibrations, and give rise in reproducing to scraping noises, which interfere with the intelligibility of the sounds reproduced. These scraping noises are greater with some other modes of reproducing which we have devised, and which will form the subject of other patents, than they are with a rubbing style; but even with the latter the additional smoothness given to the surface by the partial fusion has some advantage.

The invention consists, eighthly, in a sound-recorder having a cutting or graving style which is held by elastic or yielding pressure against the surface on which the record is to be made. The object is to enable the vibratory graver or cutting style to ride over instead of plowing through any elevations on the recording-surface. The depth to which the point of the cutting-style is embedded in the record affects the amplitude of the style's vibration. By this improvement the depth is kept uniform, notwithstanding any slight unevenness of the recording-surface.

The invention consists, ninthly, in having the recorder, of whatever description, or the reproducer, or both, rest against the tablet or recording material by gravity.

The invention consists, tenthly, in combining, with a sound-recorder or recording-instrument of any suitable description, and specially with one having a cutting-style, a tube or hollow standard on which the recorder is mounted, and through which the sound-waves are conveyed to the same. This part of the invention also consists in supporting this hollow standard on a hinge, and having a sound-conveying tube communicate with the interior thereof through the hinge. This part of the invention further consists in supporting the reproducer or reproducing-instrument on a hollow sound-conveying standard, the same as explained with respect to the recorder, and in similarly connecting the hollow standard of the reproducer with an exterior sound-conveying tube.

The invention consists, eleventhly, in combining with the recorder a mouth-piece so shaped as to include the nose of the user. It is found desirable to concentrate the sound-waves as much as possible upon the recording instrument or style, and if an ordinary mouth-piece be used the sound reproduced from the record is imperfect in the nasal elements, and sounds somewhat like the speech of a person with a cold in his head. By the use of the improved mouth-piece this disagreeable quality of the reproduced sound is avoided.

The invention consists, twelfthly, in a reproducer in which the sonorous vibrations impressed by the record upon the style are by the latter communicated to a block, plate, or other body of hard rubber, and through said body are transmitted to the air or to other vibratory medium. It is found that this material (hard rubber) gives much purer sounds than metal and other substances heretofore employed. It appears to absorb minute vibrations which give rise to scratching noises, and also to communicate sonorous vibrations without at the same time adding any foreign vibrations due to the movements of its own particles among themselves. The result is probably due to the high elasticity and the homogeneity of hard rubber.

The invention consists, thirteenthly, in combining with the disk of a recording and reproducing apparatus, in which the record is formed on the face of said disk in a volute or spiral by cutting or otherwise by any known or suitable means mechanism for giving to said disk a uniform surface-speed under the recorder. Heretofore when the record was formed on the face of a disk the latter has been given a uniform rotation, so that the same number of words were recorded in the outermost circles, as in the smaller inner ones. By giving to the disk a uniform surface-speed under the recorder, or by making the times of each rotation inversely proportional to the distance of the recorder from the center of the disk, the record of any given word or sound will be of the same length at whatever part of the disk it may be, and in this way it is possible considerably to increase the number of words or sounds on a given area.

The invention further comprises certain special constructions, combinations, and arrangements of parts, as hereinafter set forth.

Having now explained the principle of the invention, the manner in which the same is or may be applied will now be explained with reference to the accompanying drawings, which make part of this specification.

Figure 1 is a plan view of an apparatus constructed in accordance with the invention, arranged for recording; Figs. 2 and 3, respectively, a front elevation and cross-section of the same; Fig. 4, a view in section and elevation of the recorder; Figs. 5 and 6, views on an enlarged scale of the graver or cutting style; Figs. 7 and 8, views in elevation and section, respectively, of the reproducer; Figs. 9 and 10, similar views of another form of reproducer, and Fig. 11 an elevation of the sound-conveying tube for use with the reproducer. Figs. 12 to 17 represent a modified form of apparatus, Fig. 12 being a back view, partly in section; Fig. 13, a plan, partly in section; Fig. 14, an edge view, partly in section; Figs. 15 and 16, views in elevation and section of the recorder, and Fig. 17 an edge view of a friction-clamp making part of the apparatus. Figs. 18 and 19 are plan and longitudinal sections, respectively, of a form of apparatus also constructed in accordance with the invention, or with parts thereof in which the record is made on a strip, and Fig. 20 a plan, partly in section, of the reproducer for use with such apparatus. Fig. 21 is a view of a recorder in which the style is operated electrically.

Referring to Figs. 1 to 11, A is the base or bed of the apparatus, and B an upright frame, which carries the mechanism for supporting and moving the tablet F, (shown as a disk,) on which the record is to be or has been formed. In the slide C, movable in ways of the frame B, is journaled an arbor, D, on which are fixed a metal disk, E, at one end and a bevel-gear, 1, at the other. The arbor projects beyond the metal disk E, so as to form a support for the recording-tablet F, which is retained thereon by the nut 2 and washer 3. The metal disk E performs the double function of a friction-wheel and of a backing to the recording-tablet F. The bevel-gear 1 engages a similar gear, 4, on the end of the screw 5, which is journaled in a bearing in the slide C, and is tapped through a stationary lug, 6, on the frame B. As the arbor D is revolved, the screw 5 is turned also, and in consequence of its engagement with the lug 6 it moves the slide C lengthwise of the frame B. The rotation is communicated to the arbor from the shaft 7, journaled in bearings of the frame B, and provided at one end with a fly-wheel, 8, and crank-handle 9, and at the other with a friction-pinion, G. This pinion is formed, as shown, of rubber disks clamped together between metal washers. It bears against the back of metal disk E, and communicates motion to it. As the slide C is moved by the action of the screw 5, the metal disk E is carried past the friction-pinion, so that it touches the metal disk in a spiral line, and serves to give a uniform surface-speed to each part of the disk as it in turn comes opposite said pinion. The recorder H is placed on the opposite side of the metal disk E, preferably as shown, with the point of the graver or cutting style 11 directly opposite the point where the pinion G touches the disk E. The said pinion thus acts as a support to the disk against the action of the cutting or recording style. The latter is preferably formed of a round wire by turning the end conical and rounding the extremity, and then grinding off one side to the axis of the wire. This leaves sharp cutting-edges on both sides of the tapering point. These edges remove the material in chips or shavings, like a plane or turning-tool. It is not essential to give this form to the style. Any form which will remove the material and not simply displace it will answer. The style is set in one end of a block, 12, provided on the opposite end with a cup, 13, (see Fig. 4,) and secured in the cross-piece 14 by the nut 15. The cross-piece 14 is fastened to a ring, 16, into which a back plate, 17, is secured. These parts, except the steel style, are preferably of hard rubber, although they could be made of another material—of brass, for example. A sound-conveying tube, 18, is screwed into the back plate, 17, the end being just behind the cup 13. A diaphragm, 105, of any suitable material, whose edges are clamped between the ring 16 and back plate, 17, is placed behind the cup 13, which is pressed against said diaphragm by the elasticity of cross-piece 14. The cup 13 and block 12 serve to communicate the vibrations from the diaphragm to the recording-style.

The tube 18 forms part of a hollow standard, upon which the recorder is mounted. The lower part, 19, of this standard is hinged in the bracket 20, as clearly shown in Fig. 2, so that it can be rocked to bring the recorder into or put it out of action.

On the tube or standard 19 is a ring-weight, Z, which is retained in position by a set-screw, 127. It therefore can be adjusted up or down, in order to increase or diminish the pressure of the style 11 against the tablet F. The use of this weight is desirable, but not necessary.

The tube 21 communicates with the interior of the hollow standard through the hinge, and does not therefore interfere with its freedom of motion. This tube 21 can be fixed in the bracket or can be allowed to turn, as may be preferred.

The mouth-piece I is shaped to fit the face of the user, and is provided with a notch, 22, to receive the nose. It is attached to the tube 23, which at its lower end fits snugly in the tube 21 and communicates through the series of tubes 23, 21, 19, and 18 with the space inside and back of the cup 13.

In operation the recorder rests by its own weight, assisted by the pressure of weight Z, or by its own weight alone, if preferred, against the recording-tablet F, said weight causing the style to embed itself to the proper extent in the recording material. The sonorous vibrations impressed upon the style are so rapid, as well as so minute, that the record is made as perfectly as if the recorder were held positively, while at the same time the recorder can be moved bodily to conform to the unevenness of the surface of the tablet, and thus keep uniform the depth at which the style operates.

The tablet F consists of a paper or pasteboard foundation, 24, with a coating, 25, of wax. A composition excellently adapted to the purpose, and according to our experience the best, consists of one part, by weight, of white beeswax and two parts of paraffine. The two bodies are melted together, and if not perfectly free from dirt and grit should be filtered. A filtration through cotton-wool will answer. The coating is or may be about one-twentieth of an inch in thickness, (the paper being one-tenth of an inch, more or less,) and can be made by flowing the melted composition over the paper disk or foundation. The surface is preferably turned off flat on a lathe.

In order to place the tablet in the machine, the recorder H is turned back out of the way. When the tablet has been secured in place, the recorder is turned forward into the position shown, the style resting against and slightly penetrating the wax coating. A penetration of one one-hundredth of an inch has been found very effective, the style being formed of No. 16 wire shaped at the cutting end as in Figs. 5 and 6. Upon turning the fly-wheel 8 the disk E and tablet F will be turned, and the style 11 will cut or engrave a spiral line in the wax coating of the tablet. If one talks into the mouth-piece I, the style will be thrown into vibrations corresponding to the spoken words, and the engraved line will be of varying character, the inequalities or variations from uniformity representing the forms of the sound-waves.

The reproducer K, (shown in Figs. 7 and 8,) for reproducing from the engraved tablet, or from other suitable record the sounds which formed said records, has a reproducing-style, 26, formed of a narrow metal strip bent near the end, as shown in Fig. 8, and pointed, as shown in Fig. 7. This style is held by cementing, riveting, or otherwise, between the strip 27 and the circular plate 28, both preferably of hard rubber. The strip 27 is fastened at the bottom to an offset on the block 29, in which a passage is formed for the sound-waves. This passage terminates just behind the plate 28. There is a fixed disk, 30, of the same size as the movable plate 28. It is cemented or otherwise fastened on the face of the block, and is perforated at the center, in order not to obstruct the opening therein. The plate 28 is close to but not in contact with the disk. The tube 31, fixed at the upper end to the block 29, is joined at the lower end to the tube 33 by a section of soft flexible vulcanized-rubber tubing, 32. For use the tube 33 is slipped into the tube 19 in the manner shown for the tube 18 of the recorder.

The reproducer K when so placed is mounted upon a hollow standard composed of the tubes or tubing 31, 32, 33, and 19, and in consequence of the flexibility of the rubber tubing 32 it is free to follow the record. No special care is necessary to insure its adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line the style will of itself gravitate to the bottom of the groove.

There exists always a liability to disarrangement in some part of the machine either in the recorder or the support therefor or the recording-tablet or its support, or if there be no disarrangement it would be difficult to insure that the reproducing-style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent.

In operation the reproducer K is placed against the record, and on turning the wheel 8 in the same direction and at about the same speed that it was turned in recording, the record will move the style 26 and plate 28, so as to throw the air in the hollow standard into vibrations, and produce sound-waves similar to those which originally acted upon the recording-style to make the record. The reproduced sounds are audible by placing the ear in proximity to the mouth-piece I; but it is preferred to withdraw said mouth-piece, and to connect the flexible tube 34 (see Fig. 11) with the tube 21 and listen at the ear-piece 35. After the record has been cut it will of course be understood that the machine is turned back to the starting-point for reproducing. The surface of the cut record can be rendered more smooth by removing the engraved tablet from the machine and exposing the surface to heat—as, for example, by rotating the tablet-face downward over an alcohol-lamp until the surface begins to glisten. Of course a too long exposure would destroy the record. It is the merest surface action that is required. The record can be used for reproducing without submitting it to this operation and without removing it from the machine. It may, however, be removed, and at any time thereafter replaced on the same or a similar machine, and be made to reproduce the original sounds.

The reproducer K' (shown in Figs. 9 and 10) has the style 26 attached to the outer of two light plates, 36 and 37, which are attached to a diaphragm, 38, of thin sheet rubber clamped at the edges between the ring 39 and the border of the back plate, 40. The tube 31 is fastened in the back plate.

It will be observed that in both forms of reproducer the style 26 projects beyond the edge or end of the instrument, so that the position of its point on the record can be easily seen.

Referring now to Figs. 12 to 17, A is the bed, B an upright frame, D an arbor, E a metal disk, F the tablet, and G a friction-pinion, as in Figs. 1 to 11. The nut 2 and washer 3, the shaft 7, wheel 8, and crank 9, and the paper disk 24 and wax coating 25 are identical with the parts similarly numbered in Figs. 1, 2, and 3. The arbor D, instead of being journaled in a slide, is carried by an arm, L, which is supported by and is fixed on the short shaft 50. This shaft is supported on centers 51 and 52, so that the arm L can be rocked. The worm-wheel 53, loosely mounted on the shaft 50, is held stationary by the clamp M, the jaws 54 fitting on either side of the wheel, and being pressed against it by the thumb-screw 55. The arbor D carries a screw-wheel, 56, which engages the worm-pinion 57 at the upper end of shaft 58. The screw 59 at the lower end of the shaft engages the worm-wheel 53. This shaft 58 and the gears 57 and 59 carried thereby prevent the arm L being turned independently of the worm-wheel 53, except as the said shaft is rotated. As the arbor D, disk E, and tablet F are rotated, the screw 56 turns the shaft 58, and consequently—the worm-wheel 53 being held stationary by the clamp M—the arm L is swung gradually to one side, so that the recorder engraves a spiral line on the wax face of the tablet. When the record has been cut, it is only necessary, in order to restore the tablet to the starting-point for reproducing, to draw back the recorder and to loosen clamp M, when arm L can be moved at once to the proper position.

A recorder constructed and mounted precisely as in Figs. 1, 2, 3, and 4 could be used in this machine; but, as shown, the recording-instrument H′ is modified to some extent. The cutting-style 11 (which is the same as that of Figs. 4 to 6) is set into a block, 60, carried by a metal strip, 61. This is fastened to a block, 62, at the lower end of a back piece, 63, which is attached to the upper end of the tube 64, which forms the hollow standard for the recorder, and which is mounted on the bracket 65, so as to be capable of being turned to put the record into or out of action. The sound-conveying tube 66 corresponding to tube 21 of Figs. 1 and 2 communicates through the hinge with the interior of the tube 64. In front of the opening at the upper end of tube 64 is stretched a diaphragm, 67, of thin sheet metal, or it may be of other membrane or material, its edges being clamped between the ring 68 and back piece, 63, soft-rubber rings 69 and 70 being interposed one on each side of the diaphragm. On the opposite side of the diaphragm 67 from the tube 64 a light plate, 71, of metal cupped in the center, is held against the diaphragm by the pressure of the strip 61, a projection on the back of said strip bearing against the said plate 71.

In this machine the reproducer K, instead of being mounted on the same bracket as the recorder when the latter has been removed, is carried by a separate bracket, 72, the tube 33 being hinged thereto, so that the recorder and reproducer remain, or may remain, always attached to the machine, it only being necessary to turn one or the other into position, as may be required.

Referring to Figs. 18 to 20, A is the base or bed, B an upright frame, 7 the driving-shaft, 8 the fly-wheel, 9 the operating-crank handle, and G the friction-pinion, as in Figs. 1 and 2. The arbor P is supported in an upright position in bearings of the frame A B, and is revolved by the friction-pinion G engaging the friction-disk Q. The record is made on a wax-coated strip, R, of paper, which is passed around the periphery of the disk S in the groove formed thereon. As the strip passes in front of the recorder or reproducer, it is wound off one reel—say the reel T—and upon the other reel, U. The strip can be wound back upon the reel T when desired. Each reel rests by its own weight upon a platform or flange, 75, at the upper end of a hollow shaft, 76, which turns upon a stud, 77, fastened at the base to the bed B. A pin, 78, passes through the center of the reel, and forms a journal for it to turn upon. A nut, 79, holds the reel on, and may be used to bind it with more or less tension. On each shaft 76 is a belt-pulley, 80 and 81, respectively, driven by a crossed belt, 82 or 83, from a pulley, 84 and 85, on the arbor P. These pulleys 84 and 85 are loose upon the arbor, but are provided each with a clutch, 86 and 87, so placed (see Fig. 18) that when the arbor is turned to the left the clutch 87 engages the hub 89 on the arbor, and the pulley 85 is turned therewith, while when turned to the right the clutch 86 engages the hub 88. Each shaft 76 has a stop-clutch, 90 and 91, respectively, which holds it stationary when the strip is being wound on the other reel. Thus, when the arbor P is turned to the left the reel U is revolved in the direction indicated by the arrow, and the sleeve-supporting reel T is held stationary. The strip is thus stretched at all times, the degree of tension depending upon the friction between the reels and their supporting-flanges 75. The recorder H″ is carried by a cross-piece, 92, supported by posts 93. The style 11 is carried by a cross-piece, 94, to which it is attached by means of the cup 95, of hard rubber, which forms a nut on the screw-threaded shank of the style, and said cup rests against a mica diaphragm, 96, whose edges are clamped between the screw-ring 97 and the back plate, 98. The tube 18, screwed into the back plate, is fastened by soldering or otherwise to the cross-piece 92. The tube 23 of the mouth-piece I fits into said tube 18. The ends of the cross-piece 92 are slotted to fit around the screws at the top of posts 93 and rest upon nuts 99, and are clamped by nuts 100. By means of these nuts the vertical position of the recorder can be adjusted. After one line has been engraved on the strip, the recorder can be adjusted to engrave as many additional lines parallel thereto as the strip will receive. The slots in the cross-piece 92 allow the recorder to be moved toward and away from the strip, so as to regulate the depth of the engraved line. To insure a greater nicety of adjustment, screws 101 are tapped through the metal at the closed end of the slots, and bear at the point against the supporting-screws.

The reproducer K'. Fig. 20, is similar to that shown in Figs. 9 and 10, except that the style 26 is so placed that the point is at the center instead of projecting beyond the edge of the instrument. Its position on the record is therefore not so readily seen; but with the form of machine shown in these figures this is less important. The same may be said of the loose mounting of the reproducer, although in point of fact the thin rubber diaphragm 38 gives a certain lateral play to the style. The tube 31 is rigidly fastened to a cross-piece, 102, identical with the cross-piece 92, and with said tube 31 the bearing-tube 30 and ear-piece 35 are connected.

The paper strip can be easily coated with the beeswax and paraffine compound by running the same through a body of melted composition and scraping one side, leaving what adheres to the other to harden thereon.

In Fig. 21 an arrangement for operating the recorder by electro-magnetism is shown. The magnet 107 is mounted on a bar, 108, journaled in bearings in standards 109. It is provided with a bobbin, 106, of wire, surrounding the pole piece, which bobbin is included in a circuit over which electrical undulations are caused to pass by any suitable transmitting-instrument—for example, such as commonly employed on telephone-lines. In front of the pole-piece or core of the bobbin is a diaphragm, 105, of magnetic material, whose edges are clamped between the ring 16 and back plate, 17. The cup 13 should always be in contact with diaphragm 105, and is pressed against it by the spring of piece 14. This cup, as well as the style 11, block 12, nut 15, and cross-piece 14, is the same as in the recorder H of Figs. 1 and 4.

It is evident that various modifications other than those indicated can be made and the invention still be employed in whole or in part, and also that parts of the invention may be used separately.

In the foregoing description details have been given with some minuteness. This has been done to furnish the best information in our power for enabling those skilled in the art to make and use the invention, and not with the intention of limiting the invention to the precise dimensions, proportions, shapes, and materials stated.

A means has been shown for impressing vibrations upon the recording-style by an electrical current through the intermediary of an electro-magnet, in a manner similar to that in which the diaphragm of an ordinary receiving-telephone has been vibrated.

It is evident that other means heretofore used for vibrating a diaphragm could be used in place of the magnet; also, it is evident that the vibrations of the reproducing-style could be taken up and transmitted by the means heretofore used for taking up and transmitting vibrations, (those of a telephone-diaphragm, for example.)

The term "cutting" is herein employed to indicate an action in which the material is removed in chips, shavings, or other small pieces—as in engraving, turning, and the like—and not simply displaced.

The displacement of the material is not only a different operation from the cutting contemplated by this invention, but is not calculated to accomplish the objects for which cutting or graving is employed.

Having now fully described our said invention and the manner in which the same is or may be carried into effect, what we claim is—

1. The method of forming a record of sounds by impressing sonorous vibrations upon a style, and thereby cutting in a solid body the record corresponding in form to the sound-waves, in contradistinction to the formation of sound-records by indenting a foil with a vibratory style, or cutting a strip by vibrating it against a revolving disk-cutter, substantially as described.

2. The method of forming a sound-record by impressing the sonorous vibrations upon a style in a direction at right angles to the recording-surface, and thereby cutting in a solid body a series of elevations and depressions of varying depth, corresponding in form to the sound-waves, substantially as described.

3. The vibratory cutting-style of a sound-recorder, substantially as described.

4. The cutting-style, in combination with a support permitting the same to be vibrated, and means for impressing sonorous vibrations thereon, substantially as described.

5. A vibratory cutting style, in combination with a sound-conveying tube for concentrating the sound-waves upon the style, substantially as described.

6. A vibratory cutting-style, in combination with a tablet or other solid body in which the record is to be cut, and mechanism for supporting the same and moving it with reference to the said style, substantially as described.

7. A sound-record consisting of a tablet or other solid body having its surface cut or engraved with narrow lines of irregular or varied form corresponding to sound-waves, substantially as described.

8. A sound-record consisting of a tablet or solid body having its surface cut or engraved with a number of lines of variable cross-section, the irregularities or variations corresponding in form to sound-waves, substantially as described.

9. The method of forming a sound or speech record which consists in engraving or cutting the same in wax or a wax-like composition, substantially as described.

10. The sound or speech record cut or engraved in wax or a wax-like composition, substantially as described.

11. The recording-tablet of a phonograph or sound-recording machine, having as the material for recording sounds or sonorous vibra-

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tions the composition of beeswax and paraffine, substantially at described.

12. The sound or speech record cut or engraved in a wax like composition, such as the compound of beeswax and paraffine, substantially as described.

13. A tablet or body for recording sound-vibrations, consisting of a paper or pasteboard foundation and a surface-coating of beeswax and paraffine compound, substantially as described.

14. The sound or speech record cut or engraved in a wax-like composition, such as the described compound of beeswax and paraffine, constituting a surface-coating to a paper or pasteboard foundation, substantially as described.

15. The method of making a sound or speech record which consists in engraving or cutting in the recording material an irregular groove with sloping walls, the shape of the groove representing the sound-vibrations, substantially as described.

16. The method of making a sound or speech record which consists in cutting in the recording material a groove with sloping walls and of variable cross-section, the variations corresponding in form to sound-waves, substantially as described.

17. The sound-record in the form of an irregular groove with sloping walls cut in solid material, substantially as described.

18. The sound-record cut in wax or wax-like composition in the form of an irregular groove with sloping walls, substantially as described.

19. The combination, with a reproducing-style, of a mounting therefor, which leaves said style-face to move laterally, and thereby adjust itself automatically to a sound-record, substantially as described.

20. The reproducer loosely mounted on a suitable support, so that the reproducing-style is capable of a lateral movement, and may in consequence thereof adjust itself automatically on the record, substantially as described.

21. The reproducer mounted on a universal joint and held against the record by yielding pressure, substantially as described.

22. The combination, with a grooved tablet or other body having a sound-record formed therein, of a reproducer having a rubbing-style loosely mounted, so that it is free to move laterally, and thus adjust itself to the groove, substantially as described.

23. The combination, with the tablet or other body having the sound record formed therein as an irregular groove with sloping walls, of a reproducer having a style for rubbing over said record and mounted on a universal joint, substantially as described.

24. The combination, with a sound-record formed in wax or a wax-like material, of a reproducer having a rubbing style for receiving sonorous vibrations from said record, substantially as described.

25. A reproducer having a style projecting beyond the edge or end of the instrument, so that the position of the point of the style on the record may readily be seen, substantially as described.

26. In a reproducer, the combination, with a vibratory plate or diaphragm, of a reproducing-style fastened flatwise on said plate or diaphragm and bent at the end, substantially as described.

27. The method of recording and reproducing sounds by cutting the record in a wax or wax-like material, and then rubbing over the record the style of a suitable reproducing instrument, so as to impress sonorous vibrations on said style, substantially as described.

28. The method of improving a sound-record which consists in producing an incipient fusion of the surface, substantially as described.

29. The improvement in preparing a sound-record, consisting in cutting the record in a fusible material, and then producing an incipient fusion of the surface, substantially as described.

30. The sound-recorder having a vibratory cutting-style held against the recording material by yielding pressure, substantially as described.

31. The recording-instrument having a vibratory cutting-style and mounted on a hinged arm, substantially as described.

32. The combination, with the tablet or body in which the sound-record is to be made, of the recording-instrument mounted on a hinged arm and resting by gravity against the tablet, substantially as described.

33. The recorder mounted on a hollow arm or standard, which constitutes also a sound-conveyer, substantially as described.

34. The recorder mounted upon an arm or standard hinged to its bracket or base, and provided with a sound-conveyer extending lengthwise of said arm, substantially as described.

35. The recorder mounted upon a hinged arm, and combined with a sound-conveyer which extends lengthwise of the arm, and is connected at the hinge with an exterior sound-conveyer, substantially as described.

36. The reproducer mounted upon a hollow standard which forms a sound-conveyer, substantially as described.

37. The reproducer mounted on a hinged arm, and provided with a sound-conveyer extending lengthwise of said arm, substantially as described.

38. The reproducer mounted on a hinged arm, and provided with a sound-conveyer extending lengthwise of said arm, and connected at the hinge with an exterior sound-conveyer, substantially as described.

39. The combination, with a sound-recorder, of a mouth-piece shaped to surround the mouth and nose of the user, and to concentrate the sound upon the recording devices, substantially as described.

40. The combination, with the tablet, in the form of a disk, and a recorder or reproducer,

of mechanism for causing a spiral line to be traced on the disk by the recorder or reproducer at a uniform surface-speed, substantially as described.

41. The combination, with the tablet, in the form of a disk, the arbor, and the metal disk operating as a friction-wheel, of the slide, or its equivalent, such as herein shown, in which said arbor is journaled, and the friction-pinion for revolving said disk, substantially as described.

42. The combination, with the recorder or the reproducer, the disk, the arbor, and the laterally-movable support to the arbor, of the friction-pinion placed behind and bearing against the disk at a point opposite the recorder or reproducer, substantially as described.

43. The combination, with a recording-style and the support therefor, of a cup on the back of said support, and the sound-conveying tube terminating just behind the cup, substantially as described.

44. In combination with the style of a sound-reproducer, a vibratory body or plate of hard rubber, upon which vibrations are impressed by said style, and through which they are transmitted, substantially as described.

45. A tablet provided with a wax or wax-like coating, and having engraved in said coating a spiral line with inequalities or irregularities corresponding in form to sound-waves, substantially as described.

46. A tablet provided with a coating of wax or wax-like composition, and having a sound-record engraved in said coating, said engraved coating having the glazed surface which results from an incipient fusion of the wax after cutting or engraving the record, substantially as described.

47. In combination with a sound-recorder, a flaring mouth-piece shaped to fit over the face of the user and to include his nose, and communicating through a tube or contracted opening with the space behind the diaphragm of said recorder, substantially as described.

In testimony whereof we have signed this specification in presence of two subscribing witnesses.

CHICHESTER A. BELL.
SUMNER TAINTER.

Witnesses:
PHILIP MAURO,
C. J. HEDRICK.

(No Model.)

# E. BERLINER.

## SOUND RECORD AND METHOD OF MAKING SAME.

No. 548,623 Patented Oct. 29, 1895.

*Fig. 1.*

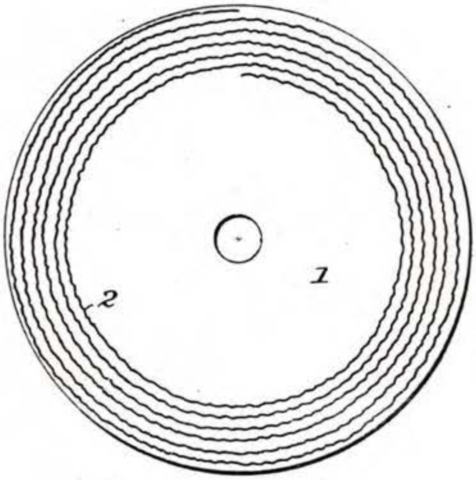
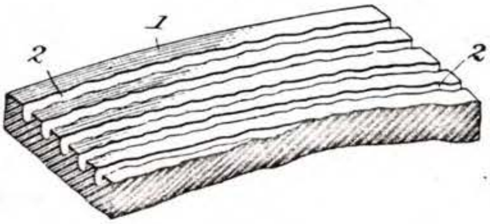


*Fig. 2.*



Witnesses
Jno. G. Hinkel,
F. T. Chapman

Inventor,
Emile Berliner,
By Joseph Lyons
Attorney

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

EMILE BERLINER, OF WASHINGTON, DISTRICT OF COLUMBIA.

## SOUND-RECORD AND METHOD OF MAKING SAME.

**SPECIFICATION** forming part of Letters Patent No. 548,623, dated October 29, 1895.

Application filed March 18, 1893. Serial No. 466,708. (No model.)

*To all whom it may concern:*

Be it known that I, EMILE BERLINER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Processes of Making Copies of Sound-Records; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in sound-records and in the method of making the same.

The present invention relates more particularly to the production of copies or duplicates of the flat sound-records as made by gramophone in the manner set forth in Letters Patent granted to me on November 8, 1887, No. 372,786, and on May 15, 1888, No. 382,790.

The sound-records, as is well-known, consists of undulatory grooves of even depth, as distinguished from non-undulatory grooves of varying depth produced by other methods of recording sounds.

The sound-records of the gramophone are generally zinc disks into which a spiral record of sound-waves is etched. Other substances than zinc capable of being etched into may of course be used.

The simplest way for making a duplicate copy of such a record is to impress it in wax, deposit copper thereon, and detach the copper shell. This is the well-known method used by electrotypers. There is, however, a loss in the perfection of the surface, resulting from the fact that electrotypers' wax is porous and uneven of surface, and the resultant copper copy containing the sound-record is not as good in tone quality as the original. It is therefore necessary to deposit a copper or other metallic matrix directly on the original zinc record. This I do by first thinly covering the zinc with a material capable of resisting the action of the sulphate of copper solution usually employed for electro plating or typing, and then deposit copper over that, and when thick enough detach the copper deposit.

My method is to cast the previously-cleaned zinc-record disk in a cyanide-of-copper or cyanide-of-brass solution, electrolytically, by which a very thin film of copper or brass adheres to the zinc. After being thus prepared, the coated zinc disk is placed into a sulphate-of-copper bath and copper deposited on it electrolytically. The deposit when thick enough is then detached and forms an accurate matrix, showing the sound-record of the zinc disk in reverse. This matrix can then be impressed into suitable material and thereby produce exact duplicates of the original record-sheet.

I have found hard rubber and celluloid to be excellent materials from which to make such duplicates. These substances when heated become very soft, and when in this soft state they are impressed with a matrix, such as above described, and are cooled while still under pressure, and the resultant rubber or celluloid sheet retains all the characters of the matrix, and thus forms a copy record of the original zinc disk. In impressing a copper matrix on softened rubber, however, the sulphur fumes which are generated when heating the rubber attack the copper and destroy the smoothness of its surface. I have therefore found it necessary to coat the copper matrix with a substance capable of withstanding the sulphur fumes, and I find electrolytically-deposited iron or nickel a proper substance to accomplish the desired effect. The copper matrix is therefore cleaned and placed in a nickel or iron bath, and a thin coating of iron or nickel is deposited on it by an electric current. The matrix thereby becomes protected against sulphur fumes, and iron and nickel being harder than copper the matrix, by being thus coated, becomes more durable, and withstands pressure for a longer period. It is also possible with such a matrix to press unvulcanized rubber into it, vulcanize the rubber while attached to the matrix, and then detach it, when a true copy of the original sound-disk will be the result.

In the annexed drawings, forming part of this specification, there is shown in Figure 1 a plan view of a sound-record made in accordance with the present invention, with the lines representing the record greatly exaggerated; and Fig. 2 is a perspective view of a small portion of a sound-record copy on an enlarged scale.

Referring to the drawings, there is shown a disk 1, of hard rubber or like material, having in its face an undulatory spiral groove 2 of even depth representing sound-waves.

What I claim is—

1. The process of duplicating flat sound records, which consists in depositing copper or other like metal on an original record, then detaching the copper reverse thus produced and facing the same with a layer of hard metal which is not attacked by sulphur, and then pressing the reverse into temporarily softened hard rubber, substantially as described.

2. The process of duplicating flat sound records, which consists in facing an electro-deposited reverse of a record, with nickel or iron, and then pressing this reverse into hard rubber, substantially as described.

3. As an article of manufacture, a sheet of hard rubber having upon its face an undulatory groove of even depth representing sound waves, substantially as described.

4. As an article of manufacture, a sheet of hard rubber having pressed into its face an undulatory line of even depth representing sound waves, substantially as described.

5. A copy of a flat sound record, which consists of a disk of hard rubber having impressed upon its face the lines representing the record, substantially as described.

In testimony whereof I have affixed my signature in presence of two witnesses.

EMILE BERLINER.

Witnesses.

S. E. YOUNG,

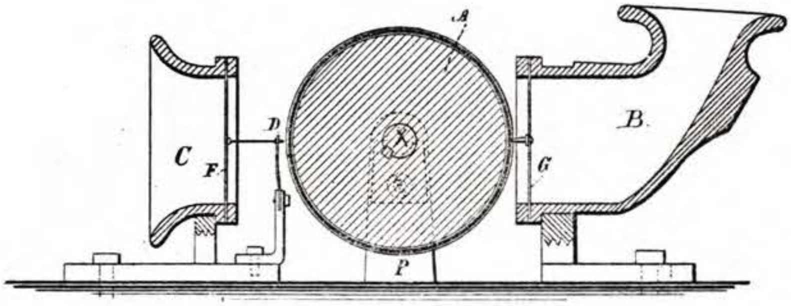
GEORGE SEIDENSPINER.

# T. A. EDISON.

## Phonograph or Speaking Machine.

No. 200,521. Patented Feb. 19, 1878.

Fig. 1.



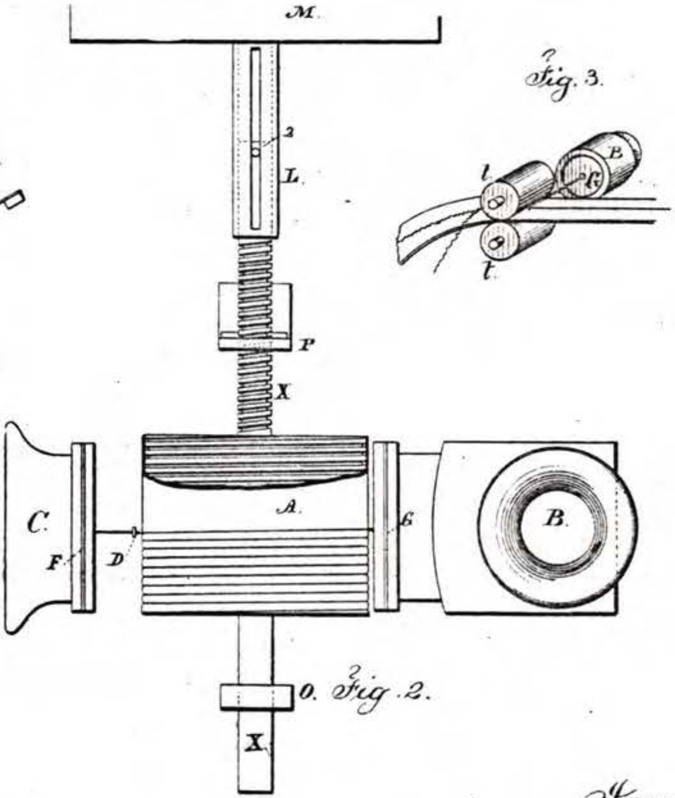


Fig. 2.

Fig. 4.

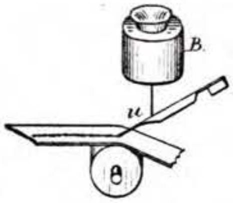


Fig. 3.

Witnesses

Chas H. Smith
Harold Serrell

Inventor

Thomas A. Edison.

per Lemuel W. Serrell
atty.

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

## IMPROVEMENT IN PHONOGRAPH OR SPEAKING MACHINES.

Specification forming part of Letters Patent No. **200,521**, dated February 19, 1878; application filed December 24, 1877.

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an Improvement in Phonograph or Speaking Machines, of which the following is a specification:

The object of this invention is to record in permanent characters the human voice and other sounds, from which characters such sounds may be reproduced and rendered audible again at a future time.

The invention consists in arranging a plate, diaphragm, or other flexible body capable of being vibrated by the human voice or other sounds, in conjunction with a material capable of registering the movements of such vibrating body by embossing or indenting or altering such material, in such a manner that such register-marks will be sufficient to cause a second vibrating plate or body to be set in motion by them, and thus reproduce the motions of the first vibrating body.

The invention further consists in the various combinations of mechanism to carry out my invention.

I have discovered, after a long series of experiments, that a diaphragm or other body capable of being set in motion by the human voice does not give, except in rare instances, superimposed vibrations, as has heretofore been supposed, but that each vibration is separate and distinct, and therefore it becomes possible to record and reproduce the sounds of the human voice.

In the drawings, Figure 1 is a vertical section, illustrating my invention, and Fig. 2 is a plan of the same.

A is a cylinder having a helical indenting-groove cut from end to end—say, ten grooves to the inch. Upon this is placed the material to be indented, preferably metallic foil. This drum or cylinder is secured to a shaft, X, having at one end a thread cut with ten threads to the inch, the bearing P also having a thread cut in it.

L is a tube, provided with a longitudinal slot, and it is rotated by the clock-work at M, or other source of power.

The shaft X passes into the tube L, and it is rotated by a pin, 2, secured to the shaft, and passing through the slot on the tube L, the object of the long slot being to allow the shaft X to pass endwise through the center or support P by the action of the screw on X. At the same time that the cylinder is rotated it passes toward the support O.

B is the speaking-tube or mouth-piece, which may be of any desired character, so long as proper slots or holes are provided to re-enforce the hissing consonants. Devices to effect this object are shown in my application, No. 143, filed August 28, 1877. Hence they are not shown or further described herein.

Upon the end of the tube or mouth-piece is a diaphragm, having an indenting-point of hard material secured to its center, and so arranged in relation to the cylinder A that the point will be exactly opposite the groove in the cylinder at any position the cylinder may occupy in its forward rotary movement.

The speaking-tube is arranged upon a standard, which, in practice, I provide with devices for causing the tube to approach and recede from the cylinder.

The operation of recording is as follows: The cylinder is, by the action of the screw in X, placed adjacent to the pillar P, which brings the indenting-point of the diaphragm G opposite the first groove on the cylinder, over which is placed a sheet of thick metallic foil, paper, or other yielding material. The tube B is then adjusted toward the cylinder until the indenting-point touches the material and indents it slightly. The clock-work is then set running, and words spoken in the tube B will cause the diaphragm to take up every vibration, and these movements will be recorded with surprising accuracy by indentations in the foil.

After the foil on the cylinder has received the required indentations, or passed to its full limit toward O, it is made to return to P by proper means, and the indented material is brought to a position for reproducing and rendering audible the sounds that had been made by the person speaking into the tube B.

C is a tube similar to B, except that the diaphragm is somewhat lighter and more sensitive, although this is not actually necessary. In front of this diaphragm is a light spring, D, having a small point shorter and finer than the indenting-point on the diaphragm of B. This spring and point are so arranged as to fall exactly into the path of all the indentations. This spring is connected to the diaphragm F of C by a thread or other substance capable of conveying the movements of D. Now, when the cylinder is allowed to rotate, the spring D is set in motion by each indentation corresponding to its depth and length. This motion is conveyed to the diaphragm either by vibrations through a thread or directly by connecting the spring to the diaphragm F, and these motions being due to the indentations, which are an exact record of every movement of the first diaphragm, the voice of the speaker is reproduced exactly and clearly, and with sufficient volume to be heard at some distance.

The indented material may be detached from the machine and preserved for any length of time, and by replacing the foil in a proper manner the original speaker's voice can be reproduced, and the same may be repeated frequently, as the foil is not changed in shape if the apparatus is properly adjusted.

The record, if it be upon tin-foil, may be stereotyped by means of the plaster-of-paris process, and from the stereotype multiple copies may be made expeditiously and cheaply by casting or by pressing tin-foil or other material upon it. This is valuable when musical compositions are required for numerous machines.

It is obvious that many forms of mechanism may be used to give motion to the material to be indented. For instance, a revolving plate may have a volute spiral cut both on its upper and lower surfaces, on the top of which the foil or indenting material is laid and secured in a proper manner. A two-part arm is used with this disk, the portion beneath the disk having a point in the lower groove, and the portion above the disk carrying the speaking and receiving diaphragmic devices, which arm is caused, by the volute spiral groove upon the lower surface, to swing gradually from near the center to the outer circumference of the plate as it is revolved, or vice versa.

An apparatus of this general character adapted to a magnet that indents the paper is shown in my application for a patent, No. 128, filed March 26, 1877; hence no claim is made herein to such apparatus, and further description of the same is unnecessary.

A wide continuous roll of material may be used, the diaphragmic devices being reciprocated by proper mechanical devices backward and forward over the roll as it passes forward; or a narrow strip like that in a Morse register may be moved in contact with the indenting-point, and from this the sounds may be reproduced. The material employed for this purpose may be soft paper saturated or coated with paraffine or similar material, with a sheet of metal foil on the surface thereof to receive the impression from the indenting-point.

I do not wish to confine myself to reproducing sound by indentations only, as the transmitting or recording device may be in a sinuous form, resulting from the use of a thread passing with paper beneath the pressure-rollers *t*, (see Fig. 3,) such thread being moved laterally by a fork or eye adjacent to the roller *t*, and receiving its motion from the diaphragm G, with which such fork or eye is connected, and thus record the movement of the diaphragm by the impression of the thread in the paper to the right and left of a straight line, from which indentation the receiving-diaphragm may receive its motion and the sound be reproduced, substantially in the manner I have already shown; or the diaphragm may, by its motion, give more or less pressure to an inking-pen, *u*, Fig. 4, the point of which rests upon paper or other material moved along regularly beneath the point of the pen, thus causing more or less ink to be deposited upon the material, according to the greater or lesser movement of the diaphragm. These ink-marks serve to give motion to a second diaphragm when the paper containing such marks is drawn along beneath the end of a lever resting upon them and connected to such diaphragm, the lever and diaphragm being moved by the friction between the point being greatest, or the thickness of the ink being greater where there is a large quantity of ink than where there is a small quantity. Thus the original sound-vibrations are reproduced upon the second diaphragm.

I claim as my invention—

1. The method herein specified of reproducing the human voice or other sounds by causing the sound-vibrations to be recorded, substantially as specified, and obtaining motion from that record, substantially as set forth, for the reproduction of the sound-vibrations.

2. The combination, with a diaphragm exposed to sound-vibrations, of a moving surface of yielding material—such as metallic foil—upon which marks are made corresponding to the sound-vibrations, and of a character adapted to use in the reproduction of the sound, substantially as set forth.

3. The combination, with a surface having marks thereon corresponding to sound-vibrations, of a point receiving motion from such marks, and a diaphragm connected to said point, and responding to the motion of the point, substantially as set forth.

4. In an instrument for making a record of sound-vibrations, the combination, with the diaphragm and point, of a cylinder having a helical groove and means for revolving the cylinder and communicating an end movement corresponding to the inclination of the helical groove, substantially as set forth.

Signed by me this 15th day of December, A. D. 1877.

THOS. A. EDISON.

Witnesses:
GEO. T. PINCKNEY,
CHAS. H. SMITH.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION** forming part of Letters Patent No. 400,648, dated April 2, 1889.

Application filed July 30, 1888. Serial No. 281,457. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 796,) of which the following is a specification.

The object of my invention is to produce phonogram blanks or bodies on which are to be produced a record of sound-vibrations, and which are to reproduce the same by the aid of the phonograph, which phonogram-blanks shall be composed of a material having superior qualities for receiving such record and reproducing sound therefrom.

I have found that the various waxes are very desirable to use in the composition of such phonogram-blanks, but that most waxes if used by themselves are too soft to be used for this purpose. I therefore mix with the wax a harder material, which will produce a harder compound.

I have found that stearic acid is an exceedingly desirable hardening material for this purpose. I may mix this material with any suitable wax—such as ceresin, beeswax, or paraffine—but of these materials I prefer to use ceresin either alone or mixed with a small percentage of beeswax. I prefer the yellow ceresin, because it is cheaper than white ceresin.

I have found the best mixture to be as follows: About one hundred parts, by weight, of ceresin, about twenty-five parts of beeswax, and about twenty-five parts of stearic acid. The materials are simply melted together by heat and the melted compound is molded in suitable molds into the shape required for the phonogram-blanks, preferably into the form of hollow cylinders.

What I claim is—

1. Phonogram-blanks made of a mixture of a wax with stearic acid, substantially as set forth.

2. Phonogram-blanks made of a mixture of ceresin and stearic acid, substantially as set forth.

3. Phonogram-blanks made of a mixture of ceresin, beeswax, and stearic acid, substantially as set forth.

4. Phonogram-blanks made of a mixture of ceresin, beeswax, and stearic acid, in about the proportion, by weight, of one hundred parts of ceresin, twenty-five parts of beeswax, and twenty-five parts of stearic acid, substantially as set forth.

This specification signed and witnessed this 27th day of July, 1888.

THOS. A. EDISON.

Witnesses:
RICHD. N. DYER,
WILLIAM PELZER.

(No Model.)

T. A. EDISON.
PHONOGRAM BLANK.

No. 406,576. Patented July 9, 1889.

Fig. 1.

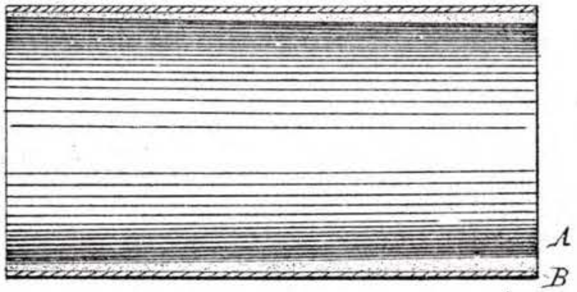
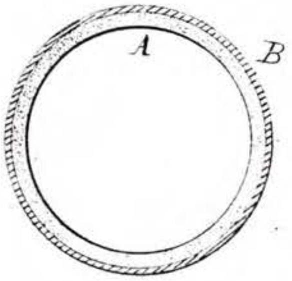


Fig. 2.



Witnesses
E. C. Rowland.
William Pelzer

Inventor
Thomas A. Edison

By his Attorneys
Dyer & Seely.

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION** forming part of Letters Patent No. 406,576, dated July 9, 1889.

Application filed February 16, 1889. Serial No. 300,514. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 829,) of which the following is a specification.

My invention relates to that character of phonogram-blanks which consist of a base or backing of one material, usually a molded material, and an outer surface or covering of another material, which receives the sound-record. Such outer recording material has usually heretofore been a material which is more or less soft and pliable at ordinary temperatures; but I have found it better for the purpose of recording and reproducing sounds to employ a material which is hard and brittle at such temperatures. When such a material is employed, difficulty may arise in cases where the phonogram-blanks are exposed to extreme changes of temperature, because the non-pliability of the sound-recording material does not permit it to accommodate itself to the expansions and contractions of the body of the blank, and so the outer material may become cracked. When the outer material is soft and pliable at ordinary temperatures, this difficulty does not usually occur, although it may arise when an extremely low temperature is encountered.

The main object of my invention is to avoid this difficulty; but a further object is to produce a phonogram-blank which can be cheaply and readily produced, and which will be effective in every way for the purpose of recording and reproducing sounds.

My invention consists, mainly, in constructing the two parts of the phonogram-blank—that is to say, the core or backing and the outer covering of sound-recording material—of substances which have the same or practically the same coefficient of expansion under changes of temperature, whereby both parts of the phonogram-blank are made to expand and contract equally, and the cracking of the outer-surface material does not occur.

I prefer to employ for the outer sound-recording surface a thin coating of a metallic soap—such as stearate of soda—and for the core or main portion of the blank I prefer to use asphalts or bitumens. Under these terms I refer not only to the natural asphalts—such as Trinidad, Cuban, Mexican, and Syrian asphalts—but also to the asphaltic residues which are produced artificially in various commercial operations, such as asphalt pitch and hard coal-tar pitch. I find that the best results are produced by the use of Syrian asphalts; but this is more expensive than some of the others, and I therefore prefer to use asphalt pitch, which is ordinary Trinidad asphalt from which the more volatile elements have been distilled. This substance is very cheap, and is found to be very effective for the purpose. In making the phonogram-blank I prefer to mix with the asphalt or bitumen a small percentage of a material which in solidifying shrinks or contracts greatly, such as certain waxes, and preferably carnauba-wax. The reason for this is, that when asphalt is melted and poured into molds it does not contract in hardening, and it is therefore difficult to get it out of the mold again. By mixing from five to seven per cent. of carnauba-wax with the asphalt a compound is formed which shrinks slightly in hardening, and can therefore be readily removed from the mold.

Asphalts as found on the market vary in the degree of heat required to melt them, and also in the degree of liquidity or mobility of the liquid which is formed by melting them. Some asphalts, even at very high temperatures, form a thick semi-liquid which is difficult to pour. This difficulty may be corrected by adding to the asphalt before melting a small quantity of a wax which has a low melting-point—such as Japan wax or ozocerite; or instead of this a liquid—such as crude petroleum, turpentine, or melted rosin or tar—may be used.

In forming the phonogram-blanks, which I prefer to make in the shape of hollow cylinders having a tapering bore and a true cylindrical outer surface, I pour the melted mixture of asphalt, carnauba-wax, and softening material into a suitable mold, such mold having a cylindrical outer inclosure and a tapering inner core, such inner core being preferably first coated with paper, which will adhere to the asphalt cylinder and allow it to be easily removed. I prefer to use a split mold, so that the cylinder can be readily removed from the mold. The outer coating, which, as stated, is preferably a metallic soap having the same coefficient of expansion as the asphalt compound employed, is preferably applied by dipping the asphalt cylinder after it has cooled into a bath of the melted material. When it is applied in this way, the surface may be afterward made true by turning it off in a suitable lathe after it has become cooled again. Instead of this, however, the external material may be also applied by molding, the asphalt cylinder being placed in a mold which is slightly larger than that first used and the covering material poured into such mold round the cylinder, so that it will adhere thereto and will form a smooth and true surface without the necessity of turning it off. My experience has been, however, that the first-mentioned method is the less expensive. There are other ways of forming the asphalt body than by melting and molding. The material may be powdered and subjected to heavy pressure in a suitable mold, so as to form it into the required shape, or it may be formed in a squirting-press—such as is used to make lead pipe—the melting material being forced through the opening in the press in a continuous tube and afterward cut into the desired lengths and then covered with the sound-recording material.

I find that the proportions of asphalt, carnauba-wax, and liquefying material necessary to produce a compound having the proper grade of expansion for the outer covering depends on the character and quality of the material and must be separately determined by experiment for each material used. In order to determine it, the three materials may be mixed in different proportions, the cylinders molded and dipped into the melted covering material, and when several cylinders of different proportions are produced in this way they may be placed in a chamber in which they are subjected to very low temperature. If the coefficient of expansion is not clearly the same, cracks will appear in the outer coatings, which will be more or less according to the proportions of material. This will show how closely the right proportions have been reached in each case, and in the second experiment it will be easy to proportion the ingredients so as to prevent cracking altogether with the particular materials used; but of course if other materials are used it will be necessary to repeat the experiment.

It will be seen that I am thus enabled to use as the sound-recording material a hard and brittle substance, and thus to make phonogram-blanks which are most effective for the recording and reproduction of sound, and at the same time the main portion of the blank is composed of a cheap and easily-worked material, and the blanks can therefore be cheaply and readily produced.

The accompanying drawings illustrate a cylindrical phonogram-blank embodying my invention.

Figure 1 is a longitudinal section of the cylinder, and Fig. 2 an end view thereof.

A is the inner body or core, and B the outer surface of sound-recording material.

What I claim is—

1. A phonogram-blank composed of a base and an outer recording-surface of different materials having the same or substantially the same coefficient of expansion, substantially as set forth.

2. A phonogram-blank composed of a base of one material and a sound-recording surface of a different material, which is of a hard and brittle nature at ordinary temperatures, the two materials having the same or substantially the same coefficient of expansion, substantially as set forth.

3. A phonogram-blank having, in combination, a base of asphaltic material and an outer covering of sound-recording material, substantially as set forth.

4. A phonogram-blank having, in combination, a base of molded material and an outer covering of material having the same or substantially the same coefficient of expansion, substantially as set forth.

5. A phonogram-blank having, in combination, a base of molded material and an outer covering of another molded material, the two materials having the same or substantially the same coefficient of expansion, substantially as set forth.

6. A phonogram-blank having, in combination, a base of asphalt mixed with a material which contracts greatly in solidifying, such as carnauba-wax, and an outer covering of sound-recording material, substantially as set forth.

7. A phonogram-blank having, in combination, a base of asphalt mixed with a liquefying material, and an outer covering of sound-recording material, substantially as set forth.

8. A phonogram-blank having, in combination, a base of asphalt mixed with a material which contracts greatly in solidifying, such as carnauba-wax, and also with a liquefying material, and an outer covering of sound-recording material, substantially as set forth.

9. A phonogram-blank having an outer surface of metallic soap and a base of another material having the same or substantially the same coefficient of expansion, substantially as set forth.

10. A phonogram-blank having a base of asphaltic material and an outer surface of metallic soap, substantially as set forth.

This specification signed and witnessed this 1st day of February, 1889.

THOMAS A. EDISON.

Witnesses:
W. PELZER,
D. H. DRISCOLL.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION** forming part of Letters Patent No. 430,274, dated June 17, 1890.

Application filed July 30, 1888, Serial No. 281,454. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 793,) of which the following is a specification.

My invention relates to phonogram-blanks for receiving a record of sound-vibrations and reproducing the same; and my object is to produce blanks having superior qualities for recording and reproducing such vibrations.

To this end my invention consists, mainly, in making such blanks, which are preferably of cylindrical form, of soap of the character hereinafter described. Said material may be employed alone or mixed with other materials, such as waxes, resins, or gums.

Insoluble soap may be formed of any metal or sometimes of an earthy oxide, like lime, in combination with any fatty acid. For my purpose, however, it is best to use lead, magnesium, or aluminium, combined with oleic or stearic acid, forming an oleate or stearate of the metal used. These compounds are preferred because of their superior amorphous quality. Of the metals named I especially prefer to employ lead, and especially to use a mixture of equal quantities of oleate and stearate of lead, the same being melted and poured into molds to form the cylindrical blanks.

The soap may be made according to the usual well-known methods.

What I claim is—

1. Phonogram-blanks made of metallic soap, substantially as set forth.

2. Phonogram-blanks made of lead soap, substantially as set forth.

3. Phonogram-blanks made of a mixture of oleate and stearate of lead, substantially as set forth.

This specification signed and witnessed this 14th day of July, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
A. W. KIDDLE.

(No Model.)

# T. A. EDISON.

## PROCESS OF DUPLICATING PHONOGRAMS.

No. 484,582. Patented Oct. 18, 1892.

Fig. 1

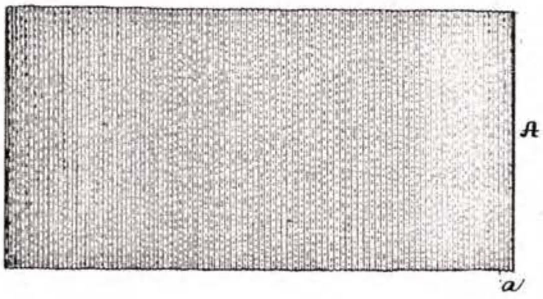


Fig. 2.

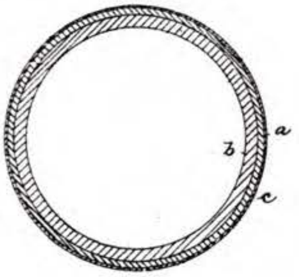


Fig. 3.

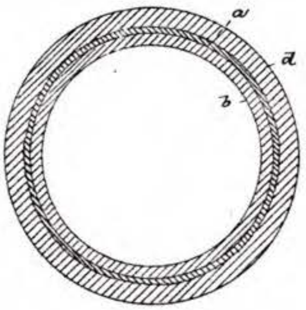


Fig. 4.

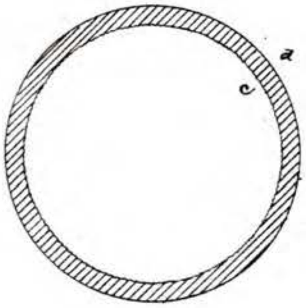


Fig. 5.

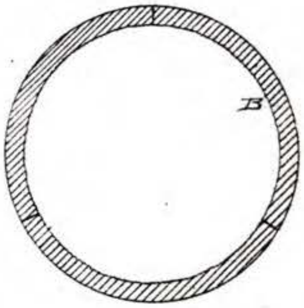


Fig. 6.

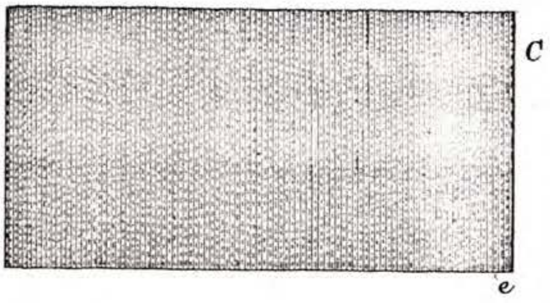
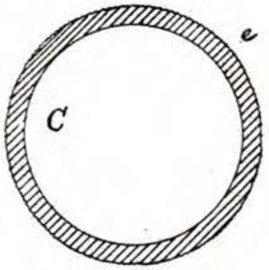


Fig. 7.



Witnesses
E. C. Rowland
William Pelzer

Inventor
Thomas A. Edison,
By his Attorneys Dyer & Seely

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO
THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

## PROCESS OF DUPLICATING PHONOGRAMS.

**SPECIFICATION** forming part of Letters Patent No. 484,582, dated October 18, 1892.

Original application filed January 5, 1888, Serial No. 259,895. Divided and this application filed January 30, 1888. Renewed March 30, 1892. Serial No. 427,011. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Process for Duplicating Phonograms, (Case No. 751,) of which the following is a specification.

The object I have in view is to produce a practical process for the duplication of phonographic records, so that the new art of phonographic publication can be established. Generally I propose to construct a suitable matrix, preferably in metal, and by its use mold duplicate phonograms with the phonographic records thereon, such phonograms or the surface thereof being preferably constructed of a material too hard for the satisfactory indentation thereof by the phonograph-recorder; but the duplicate phonograms may be made of a softer material. For the construction of the matrix I employ the process of vacuous deposit described in my application, Serial No. 118,942, filed January 28, 1884. The original phonogram is preferably constructed with a surface of wax or a similar material. This is placed in a suitable phonograph and the phonographic record produced thereon. The phonogram so impressed with the phonographic record is placed in a high vacuum, in which an electric arc, continuous or discontinuous, is produced between electrodes of metal or in which metal vapor is otherwise produced. The electric arc produces a vapor of the metal of which the electrodes are composed, which vapor or a metallic vapor otherwise produced within said chamber is deposited on the indented surface of the phonogram, forming a layer of metal thereon, which follows accurately all the indentations of the record, however minute, owing to the highly-comminuted condition of the metal deposited. The phonogram while the deposit is taking place in the vacuum-chamber is revolved slowly by a suitable power-connection, and this is especially necessary when the form of the phonogram is cylindrical, which it preferably is. The vacuous deposit is continued until the layer of metal is sufficiently thick, when the covered phonogram is removed from the vacuum-chamber and is further covered by a more rapid process to give strength and body to the covering. A further covering of metal may be produced by electroplating a metal upon the vacuous deposit in the usual manner of electroplating, or the vacuous deposit may be backed up by casting upon it type-metal or other metal or alloy having a lower fusing-point than the vacuous deposit, or this may be done after electroplating upon the vacuous deposit, or the vacuous deposit may be backed up by a a cement or gum or by plaster-of-paris; but a metal backing is preferred. The material of the original phonogram is then dissolved off of the metal covering, leaving in the case of cylindrical phonograms a hollow metal cylinder or one internally faced with metal, carrying the phonographic record in relief upon its inner surface. This metal cylinder is then split longitudinally by a very thin saw into a number of parts—say, for illustration, three parts—which are suitably mounted upon levers, so that a mold is formed, which can be closed to receive the material to be molded and opened to permit of its being taken out. The duplicate phonograms are produced by means of this mold by pouring therein and preferably around a suitable core placed in the mold suitable substances, such as wax or wax-like material, resin, or plaster-of-paris, the material being preferably too hard to be satisfactorily indented by the phonograph, or the duplicate phonograms may be made by taking sheets of smooth material, like waxed paper or tin-foil, and pressing them upon the surface of the mold by a plunger or otherwise, the sheets being afterward backed up by a wax, resin, or cement. The latter way of making the duplicate phonograms is especially applicable to flat-surface phonograms, although it may be used for phonograms with cylindrical surfaces. The production of the first layer of metal upon the phonograph-record by means of the vacuous deposit has great advantages over doing this by electroplating. In electroplating the wax-surface must first be covered by plumbago or gold-leaf or silver salts reduced by chemical reagents in order to form a conducting basis for the plating. The plumbago and gold-leaf do not bring out the fine vibrations and produce rough reproductions while the silver salts do not run well on the wax surface. The vacuous deposit, however, adheres uniformly to the wax surface and reproduces the record with great perfection.

The invention is illustrated for convenience in connection with a cylindrical phonogram.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation of an original phonogram; Fig. 2, a cross-section of the original phonogram with a thin vacuous deposit thereon; Fig. 3, a view similar to Fig. 2, with a further backing; Fig. 4, a view the same as Fig. 3, with the original phonogram dissolved out; Fig. 5, a sectional view of the divided mold or matrix; Fig. 6, an elevation of a duplicate phonogram produced by the mold, and Fig. 7 a cross-section of such duplicate phonogram.

A is the original phonogram, having a relatively-soft wax or wax-like surface *a* and the backing of harder material *b*, or it may be entirely of wax. The phonographic record is produced upon the surface *a*. The metallic vacuous deposit is shown at *c*, and the further backing, preferably of metal, is shown at *d*.

B is the divided mold, produced as has been stated and having the phonographic record in relief.

C is the duplicate phonogram, produced by the mold and having a surface *e*, indented with the phonographic record and preferably of harder material than could be practically or satisfactorily indented directly by the phonograph.

My invention herein is limited to constructing the matrix or mold by covering the phonograph-record by a vacuous deposit.

The broad invention of duplicating phonograph-records and of producing matrices for that purpose, not limited to the use of the vacuous deposit as a step in the process of reproducing the phonographic record or constructing a matrix for that purpose, is not claimed herein, such broad subject-matter being covered by an application for patent filed by me January 5, 1888, Serial No. 259,895, of which this specification is a division.

What I claim is—

1. The process of forming a matrix or mold for the duplication of phonographic records, consisting in covering the phonograph-record with a deposit of metal by vaporizing metal in a vacuum in which the record is placed, substantially as set forth.

2. The process of forming a matrix or mold for the duplication of phonographic records, consisting, first, in indenting the original record on a phonogram; second, covering the recording-surface of such phonogram with a deposit of metal by vaporizing metal in a vacuum in which such phonogram is placed, backing up such deposit to give it strength, and then removing the original phonogram, substantially as set forth.

3. The process of forming a matrix or mold for the duplication of phonographic records, consisting, first, in indenting the original record upon a phonogram having a wax-like surface; second, covering the recording-surface of such phonogram with a deposit of metal by vaporizing metal in a vacuum in which such phonogram is placed, backing up such deposit to give it strength, and then removing the original phonogram, substantially as set forth.

4. The process of duplicating phonograms carrying a phonographic record, consisting, first, in indenting the original record upon a phonogram; second, constructing a matrix or mold of such original record by depositing thereon a coating of metal by vaporizing metal in a vacuum in which the record is placed, and, third, producing duplicate phonograms from such matrix, substantially as set forth.

This specification signed and witnessed this 17th day of January, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

# T. A. EDISON.

## PHONOGRAPH CUTTING TOOL.

No. 484,583. Patented Oct. 18, 1892.

Fig. 1.

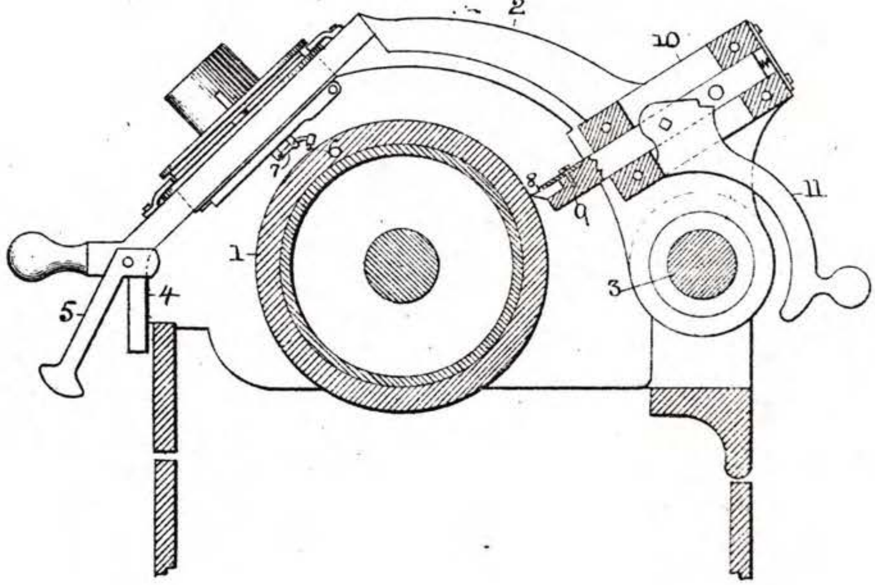


Fig. 2.

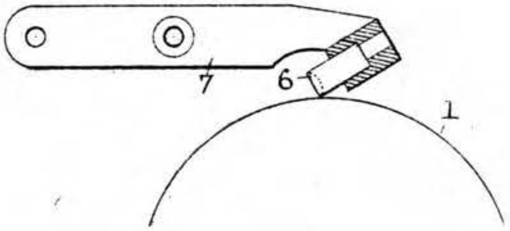
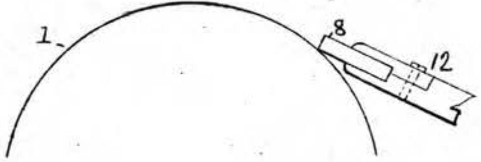


Fig. 3.



Witnesses

Norris A. Clark

Charles M. Catlin.

Inventor

T. A. Edison.

By his Attorneys Dyer & Seely.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAPH CUTTING-TOOL.

SPECIFICATION forming part of Letters Patent No. 484,583, dated October 18, 1892.

Application filed May 27, 1890. Renewed March 30, 1892. Serial No. 427,012. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a new and useful Improvement in Phonograph Cutting-Tools, (Case No. 861,) of which the following is a specification.

In practice it is found that after phonographs have been in use for a time the articulation of the speech reproduced is not so smooth and clear as when the phonograph was first put in use. While the articulation is sufficiently good to be intelligible, the false or extraneous vibrations are such as to cause unpleasant and sometimes confusing noises at the reproducer. I attribute this to the fact that by continued use the cutting-edge of the recorder and of the turning-off tool and the bearing point or end of the reproducer become roughened and this causes false marks to be made on the phonogram-blank. The recording-surface of the phonogram-blank is ordinarily of wax or a stearate or hard metallic soap or other wax-like material or composition, and it would naturally be supposed that a tool of steel of the best quality would be entirely satisfactory for use in connection with such a comparatively-soft substance. I have, however, found that such tools are subject to the objection above set forth. This is due to the chemical action of acids or other substances found in the wax-like material or composition of which the phonogram-blank is made and to the dulling and roughening action of fine particles of silica or other hard material which become mixed with the wax-like material during the manufacture of the blank or which become lodged on the surface thereof. After many trials I have found that a sapphire or other similar jewel co-operates in the most effective manner with the wax-like phonogram-blank, since the acids thereof do not attack these substances, they are not rusted by moisture, and they are adapted to withstand the dulling action of the hard particles referred to.

The present invention consists in a cutting-tool (which may be either the recording-point or the turning-off tool) for a phonograph of a jewel or similar substance which will withstand the corroding action of acid and in certain combinations which will be hereinafter described and claimed.

The reproducer is not claimed herein, since it forms the subject of another application filed on even date herewith.

In the accompanying drawings, which illustrate the invention, Figure 1 is a side view, partly in section, of a phonograph of well-known form with the improved cutting-tools attached. Fig. 2 shows the recorder on a larger scale, and Fig. 3 is a view of a turning-off tool of slightly-different shape from that illustrated in Fig. 1.

1 is the wax-like phonogram-blank, mounted on a cylinder in the ordinary manner.

2 is the arm carrying the recorder and sleeved onto the guide-rod 3 and movable thereon.

4 is the guide-rest, on the upper edge of which the recorder-frame bears and along which it slides.

5 is a cam-lever for raising the frame and thereby removing the recorder from the surface of the blank.

6 is the recorder, preferably of sapphire, as above described. In the form shown the recorder is in the shape of a cylinder, the outer end being hollowed out, thus leaving a curved sharp edge for cutting the surface of the blank. This particular form does not constitute a part of the present invention, since it is claimed in my application, Serial No. 306,670, dated April 10, 1889. This cutting-tool is mounted in a socket or sleeve at one end of the pivoted lever 7, the opposite end of which is connected to the phonograph-diaphragm.

8 is a cutting-tool, which is technically termed the "turning-off" tool, and which is used for removing a previous record and for giving a smooth and even surface to the blank on which to impress a new record. This tool is also made of sapphire or of quartz, agate, or similar hard material not readily affected by the acids. In the construction shown it is clamped to the carrier 9, which is movable in the holder 10, and 11 is a handle for moving the cutting-tool onto or off from the surface of the blank.

I have found that a turning-off tool which does not have a sharp cutting-edge, but has such edge ground away to form a right angle or approximately a right angle, so that the edge will not enter beneath the surface of the material, can be used to advantage. As such an edge cuts the material, it breaks it above the cutting-edge, so that the chips do not carry with them any portion of the blank below the line of cutting. This form of turning-off tool is illustrated in Fig. 3, where 8 is the sapphire cutting-tool supported in the clamp 12. This tool is supported, as indicated, so as to present its cutting-edge obliquely to the surface of the phonogram-blank.

Having thus described my invention, what I claim is—

1. In a phonograph employing phonogram-blanks of wax-like material, and in combination with a holder for such blanks, a jewel cutting-tool situated with relation to said holder, so as to operate upon the blank held thereby, substantially as set forth.

2. The combination, in a phonograph, with a phonogram-blank of comparatively-soft material, of a jewel recorder, substantially as described.

3. The combination, in a phonograph, with a phonogram-blank of a wax-like material, of a sapphire recorder, substantially as set forth.

This specification signed and witnessed this 24th day of May, 1890.

THOS. A. EDISON.

Witnesses:
A. O. TATE,
THOMAS MAGUIRE.

(No Model.)

# T. A. EDISON.
## PHONOGRAM BLANK.

No. 488,191. Patented Dec. 20, 1892.

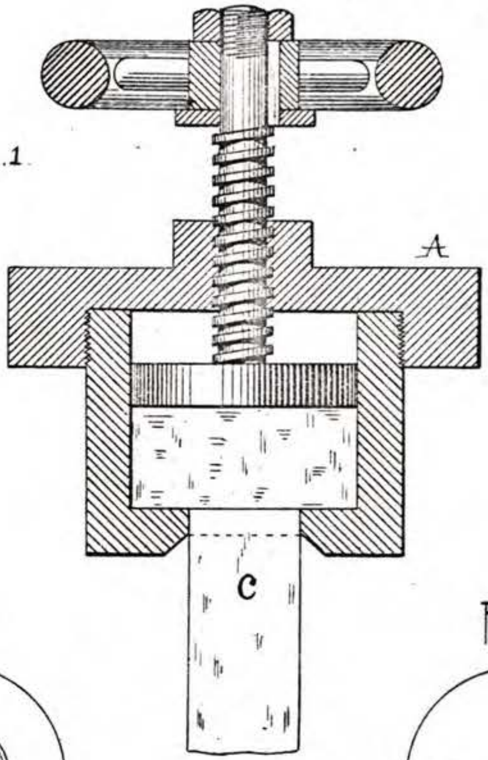


FIG. 1.

FIG. 3.

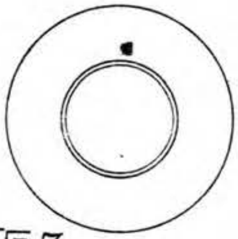


FIG. 2.

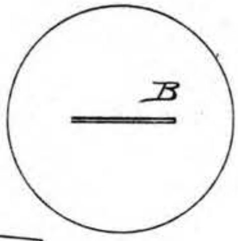


FIG. 7.

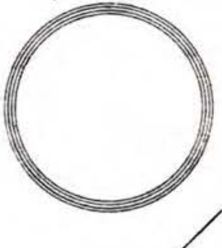


FIG. 4.

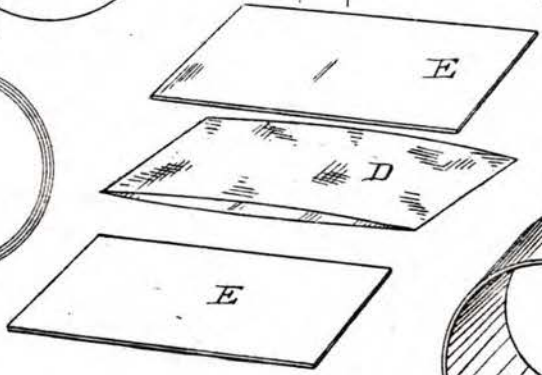


FIG. 6.

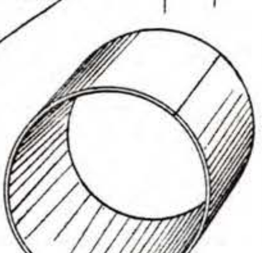
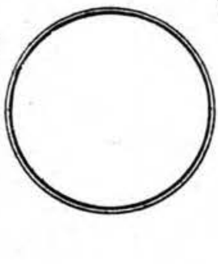


FIG. 5



WITNESSES:
S. C. Rowland
W. Pelzer

INVENTOR
Thomas A. Edison
BY
Geo.
ATTORNEYS.

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PHONOGRAM-BLANK.

**SPECIFICATION** forming part of Letters Patent No. 488,191, dated December 20, 1892.

Application filed January 19, 1889. Serial No. 296,876. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 812,) of which the following is a specification.

The object of this invention is to provide phonogram blanks or surfaces for receiving sound records in the phonograph, which shall be of a convenient and simple form and can be cheaply and readily manufactured, and which will be adapted to be conveniently packed in boxes and inclosed in envelopes for transmission by mail.

The main feature of the invention consists in the use of thin flexible sheets of wax or wax like material, which sheets either by themselves or combined with backings of other suitable material, are used as the recording mediums in phonographs. I may form such sheets of plastic flexible material, by rolling or pressing such material into sheets, but I prefer to produce them by forcing the material through an aperture of the desired form in a press. The sheets thus formed may be used in a variety of ways. Such sheets may themselves form flat recording surfaces for the phonograph, or they may be attached to backings of paper or similar flexible material and used as flat recording surfaces, or they may be formed into cylinders, either with or without an internal backing of paper or like material, or they may be placed upon rigid cylinders and used in the phonograph, or used in various other ways.

There are many compounds of wax or wax like material which may be employed for the purposes of my invention. What I prefer to use is a mixture of asphalt with Japan wax or pitches made from the distillation of fatty oils or combinations of fatty acids, any of which materials are equivalents of wax for the purposes of this invention. The proportions of the different substances will vary as the conditions differ and as sheets of different degrees of flexibility are required. Beginning with the asphalt alone, which is brittle even in thin sheets, the flexibility may be brought to any desired degree by adding more or less of the Japan wax or equivalent flexible substance.

My invention is illustrated in the accompanying drawings:

Figure 1 illustrates the use of the squirting press for forming the thin sheets. Figs. 2 and 3 are bottom views of different forms of the press; Fig. 4 shows the preferred method of placing such thin sheets upon a paper backing; Fig. 5 illustrates a cylinder thus formed; Fig. 6, a cylinder formed from the plastic sheet alone; and Fig. 7 shows a cylinder formed of a number of plastic sheets which are intended to be torn off as they are used.

A quantity of the material, such as above described, is placed in the press A in the bottom of which is usually a slot or elongated aperture B, (Fig. 2.) The material is raised to such temperature as will insure its easy passage through the aperture, and the pressure is then applied, and the material forced in the form of a thin sheet C through the aperture, as illustrated in Fig. 1. I prefer to allow it to pass directly into water, so as to set it immediately, and prevent distortion while it is in a heated condition. After it is dry, it may be coated with fine powder, such as talc or kaolin, to prevent the surface from adhering to other objects, and the strip which has come from the press is then cut up into sheets of the required size. These sheets may, as above stated, be used in many different ways. The sheet may be bent around a forming cylinder and the ends overlapped and pressed together, the surplus material being removed by a cutting or scraping tool, or preferably the ends are made to meet and are joined together by the application of a heated wire or by the addition of a small amount of the softened material along the joint. By this means cylinders like that shown in Fig. 6 are formed. Instead of this however, a sheet of thin paper may be cut to the proper size and formed into a cylinder with its edges joined, and this cylinder is then collapsed into a flat double sheet as illustrated in Fig. 4, the collapsed cylinder being shown at D. The double sheet D is placed between two sheets E E of the flexible wax like material and the whole is submitted to pressure. The backs of the sheets E, or the sheet D being previously moistened with a solvent of the flexible material, such as benzol, the sheets E are thus made to adhere firmly to the sheet D, whereby a collapsed phonogram blank is formed, which can be drawn out into a cylinder and placed upon the cylinder of the phonograph, or upon a false shell placed thereon. A cylinder drawn out into form for use is shown in Fig. 5.

Instead of a backing of paper, the thin flexible sheets formed into cylinders like Fig. 6 or used in sheet form, as flat recording surfaces, may be covered with a varnish, such as a solution of a suitable gum, like gum balata, in a solvent such as bi-sulphide of carbon. A number of sheets of this character can be formed into a composite cylinder as shown in Fig. 7, the different layers, one of which is affected at a time by the phonograph recorder, being torn off as they are used.

The squirting press may have an annular aperture as shown in Fig. 3, whereby the material may be forced out in the form of cylinders instead of in sheets.

What I claim is:

1. A collapsible phonogram blank consisting of a cylinder of flexible material with separable sheets of flexible wax or wax like material placed thereon, substantially as set forth.

2. A composite phonogram blank, consisting of two or more separately removable layers of recording material, each layer being of such thickness that a record impressed on one layer will not be transmitted to a succeeding layer substantially as set forth.

3. A composite phonogram blank, consisting of a cylinder of two or more separately removable layers of recording material, each layer being of such thickness that a record impressed on one layer will not be transmitted to a succeeding layer substantially as set forth.

4. A phonogram blank having in combination super-imposed separable layers of flexible wax or wax like material, substantially as set forth.

This specification signed and witnessed this 10th day of January, 1889.

THOMAS A. EDISON.

Witnesses:
H. W. SEELY,
W. PELZER.

(Specimens.) 2 Sheets—Sheet 1.

# T. A. EDISON.

## ART OF PLATING ONE MATERIAL WITH ANOTHER.

No. 526,147. Patented Sept. 18, 1894.

Fig 1.

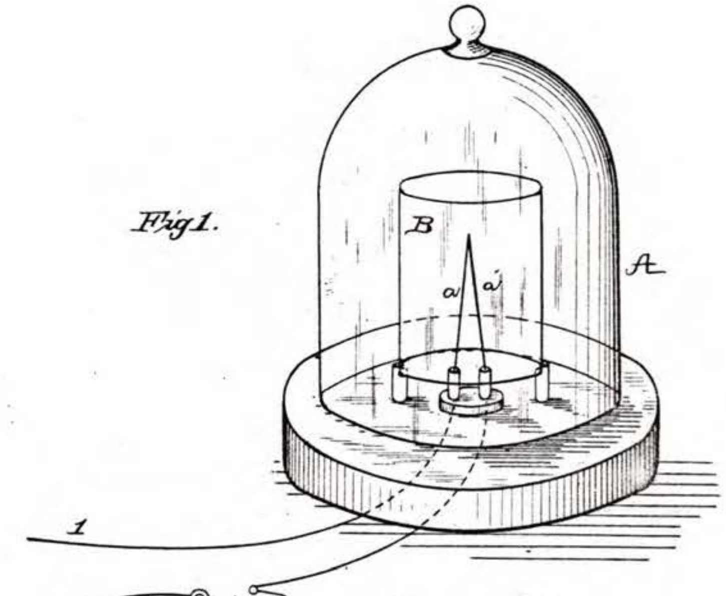
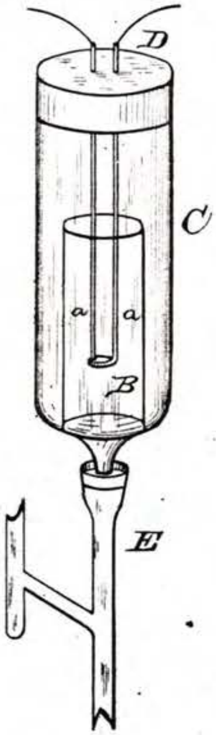


Fig 2.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich'd N. Dyer,
Atty.

THE NORRIS PETERS CO., WASHINGTON, D. C.

(Specimens.)

2 Sheets—Sheet 2.

# T. A. EDISON.

## ART OF PLATING ONE MATERIAL WITH ANOTHER.

No. 526,147. Patented Sept. 18, 1894.

Fig. 3.

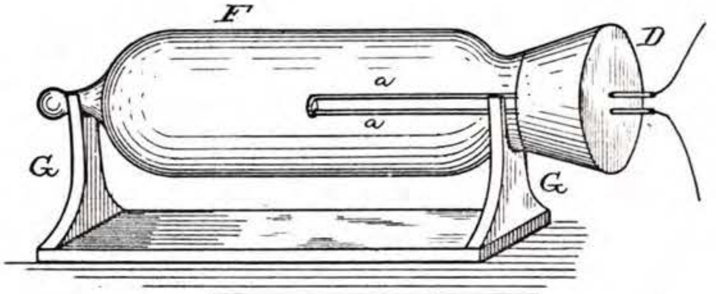


Fig. 4.

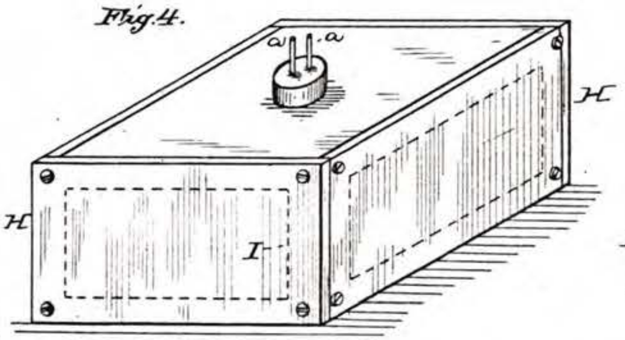


Fig. 5.

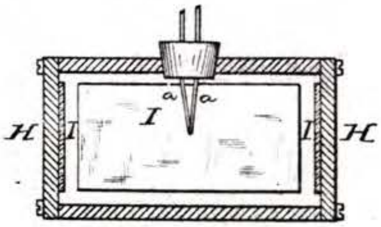
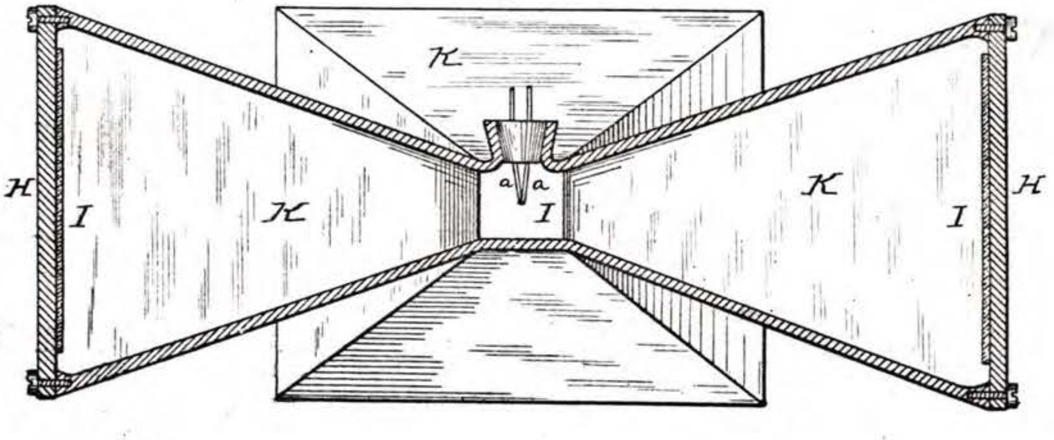


Fig 6.



WITNESSES:

E. G. Rowland

A. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich'd N. Dyer,

Atty.

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

## ART OF PLATING ONE MATERIAL WITH ANOTHER.

**SPECIFICATION** forming part of Letters Patent No. 526,147, dated September 18, 1894.

Application filed January 28, 1884. Serial No. 118,942. (Specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Art of Plating One Material with Another, (Case No. 615,) of which the following is a specification.

The object of this invention is to produce a coating of one material upon another; and said invention consists in producing such a coating by throwing the material to be deposited into the form of a vapor in a vacuum, by means of a continuous current, the object to be coated or plated being within the vacuous chamber so that the material is deposited upon it from the vapor.

I vaporize the material by electrical heating and the best method of doing this is to place electrodes of the depositing material in the vacuum chamber, forming a continuous arc between them. A dense even homogeneous and adherent deposit will then be rapidly formed upon the interior walls of the chamber and upon the surface of any object which may be placed within said chamber.

The deposit may be obtained by rendering the material to be deposited electrically incandescent within the vacuum by means of a continuous current, but the arc process is more rapid; also, I may produce a deposit of a non-conducting material by coating a conductor of carbon with such material and heating the same to incandescence. The material will be vaporized and deposited, while the carbon will withstand the heat. Any substance which will volatilize in the incandescent heat may be so used. This process of depositing in an exhausted chamber by electrical vaporization by means of a continuous current or a continuous arc, as distinguished from an intermittent current and from a series of sparks, I term electro vacuous deposition.

My invention is adapted to the plating of any material whether a conductor or non-conductor of electricity, while in the ordinary process of electro-deposition only conductors can be treated.

The uses of the invention are almost infinite, for coatings of any material and of any desired thickness may be formed. Metal sheets so fine as to be transparent and yet even and homogeneous can readily be produced.

It is found especially advantageous in coating glass for mirrors as a very even deposit can be obtained in a very simple manner.

Alloys or compositions of different metals or substances may be produced by making each electrode of a different metal.

To produce a more rapid deposition two or more arcs may be formed in the chamber.

The invention may be applied to the manufacture of metallic foil especially gold, silver, and platinum foil. To accomplish this a cylinder of polished glass, coated internally with a film of material soluble in alcohol or water, such as shellac or gelatine, is placed in the exhausted chamber, and the arc is formed within said cylinder, upon the interior of which an even coating of the metal or alloy is formed, which can be stripped off in a homogeneous sheet, with the soluble material which is then dissolved off; or a very thin film of gold, silver or platinum may be formed upon a backing of cheaper material or upon both sides of a sheet of such material.

It is evident that the deposit may be made upon flat plates or upon objects of any form whatever; and by using screens of different forms to intercept portions of the deposit, which proceeds in straight lines from the arc, the deposit may be made in any pattern or design. The finest tracery of lace, for instance, may thus be accurately reproduced in any metal.

I may use an ordinary piston air-pump and form the arc and place the object to be plated, within the exhausted bell-jar or receiver thereof. The evenness of the deposit, however, increases with the degree of vacuum, and on this account it is often desirable to employ a Sprengel pump and by keeping the same continually in operation, constantly maintain the vacuum at the highest point.

To coat small articles, a number of them may be placed in an exhausted receiver, adapted to be rotated. The arc being formed and the receiver turned, the articles are coated evenly on all sides.

For coating mirrors, I cement the glass plates upon the inner side of the removable walls of an air tight box, which is exhausted and in which the arc is formed, a deposit being made upon the glass, which is then removed.

My invention is illustrated in the annexed drawings, in which—

Figure 1, illustrates the use of a piston air pump where the deposit is made on the interior of a glass cylinder. Fig. 2, represents a Sprengel vacuum pump used in the same way. Fig. 3, shows the rotating receiver for coating small articles. Fig. 4, is an elevation of a box for coating mirrors; Fig. 5, a section of the same; Fig. 6, a section of a form of box used for very large mirrors.

Referring first to Fig. 1, A is the exhausted bell-jar of an air pump and B is a hollow glass cylinder placed therein.

Electrodes *a*, *a*, of the desired metal are placed in the cylinder with their ends a little apart or very slightly in contact so that an arc is formed between them.

The circuit wires 1, 2, lead to the electrodes from any suitable source of continuous electric current whereby a continuous arc is produced between the electrodes.

An adjustable resistance R may be placed in the circuit to regulate the current.

The glass cylinder is internally coated with a soluble material such as shellac or gelatine. The deposit is rapidly and evenly formed on the interior of the cylinder, and is readily stripped off in homogeneous sheets, together with the soluble coating which may then be dissolved off.

In Fig. 2, a receiver C, hermetically closed by a rubber stopper D is placed in connection with the exhaust tube of a Sprengel pump E. The cylinder B is suitably supported in said receiver and the electrodes *a*, *a*, are inclosed by such cylinder. The operation of the pump being continued the highest vacuum is maintained throughout the whole process of deposition.

It is evident that any object which is to be plated may be substituted for the glass cylinder in the receiver or bell-jar.

In Fig. 3, a receiver F is shown, adapted to be rotated in supports G, G.

The electrodes *a*, *a* pass through the rubber stopper D. Any object or objects placed within the receiver will, when it is rotated, receive an even deposit. For instance, hooks and eyes, or small articles of jewelry may be readily plated in this way.

In Figs. 4 and 5, H, H, are the sides of the box, preferably of iron and removably secured together with air tight joints. Upon the inner sides are cemented plates of glass I, I, from which mirrors are to be made and which receive the deposit from the arc, formed by the electrodes *a*, *a*.

For very large plates of glass, the box shown in Fig. 6 is used, with compartments K, K, diverging from the center at which the arc is placed. The vaporous particles extend in straight lines in every direction from the arc, and consequently deposit evenly upon the glass plates I, I. The box is then taken apart and the glass plates are removed. The deposit is so even that it may be made very thin, and the thin coating of silver backed up by zinc or other cheaper metal.

I am aware of experiments which have been made in which by the use of a high tension induction spark between electrodes in a vacuum it was found that a coating was produced in a vacuum chamber. This is merely a laboratory experiment and could not be practically applied because the formation of the deposit by the intermittent or alternating spark is too slow to be commercially useful. I have found that by using a continuous arc the process is made infinitely more rapid and certain, so that the useful results hereinbefore enumerated can be produced on a commercially practicable scale.

What I claim is—

1. The process of plating bodies with electrical conducting material, which consists in supporting the body to be plated in an exhausted chamber, supporting an electrode of the material to be deposited in said chamber, electrically vaporizing such metal in the chamber, and moving said body to bring different portions of it successively into proximity to the electrode of the material being deposited, substantially as described.

2. The process of plating bodies with electrical conducting material which consists in supporting the body to be plated in an exhausted chamber, supporting electrodes of the material to be deposited in said chamber, maintaining a continuous electric arc between said electrodes in the vacuum, and moving said body to bring different portions of it successively into proximity to the electrode or electrodes of the material being deposited, thereby coating the body evenly, substantially as described.

3. The process of plating bodies with an alloy or composition of electrical conducting materials, which consists in supporting the body to be coated in an exhausted chamber, supporting electrodes of different conducting materials in said chamber, and maintaining an arc between said dissimilar electrodes, substantially as described.

4. The process of making metallic foil, which consists in providing a suitable body in an exhausted chamber, and an electrical circuit extending within the same and including within the chamber a section of the metal to be made into foil, maintaining a continuous current in said circuit whereby metal is deposited on said body, and subsequently stripping off said deposited metal, substantially as described.

This specification signed and witnessed this 22d day of January, 1884.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

Raymond R. Wile Research Library

**No. 667,662.** **Patented Feb. 5, 1901.**

## T. A. EDISON.

## PROCESS OF DUPLICATING PHONOGRAPH RECORDS.

(Application filed May 8, 1900.)

**(No Model.)**

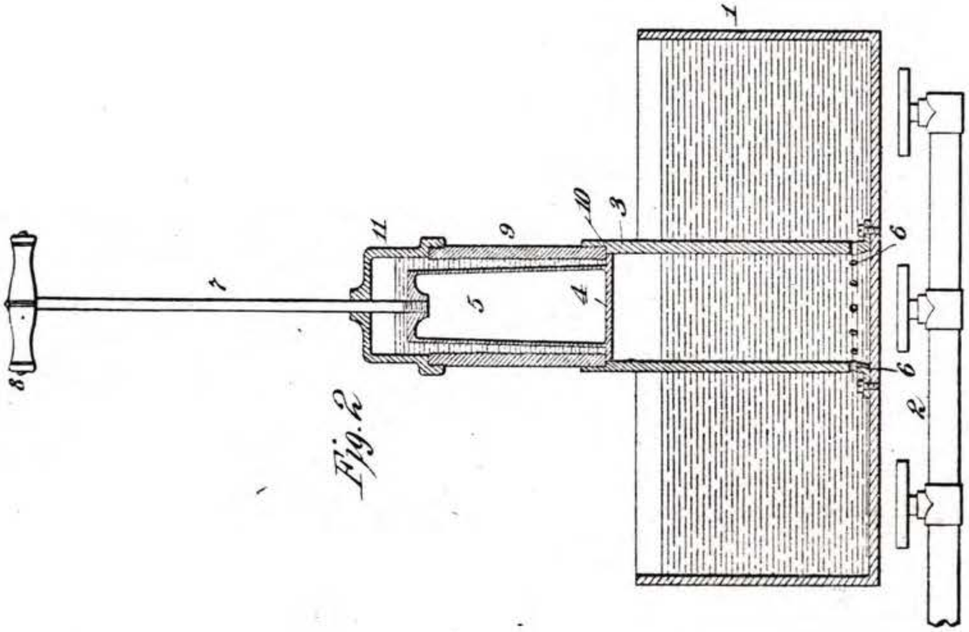


Fig. 2

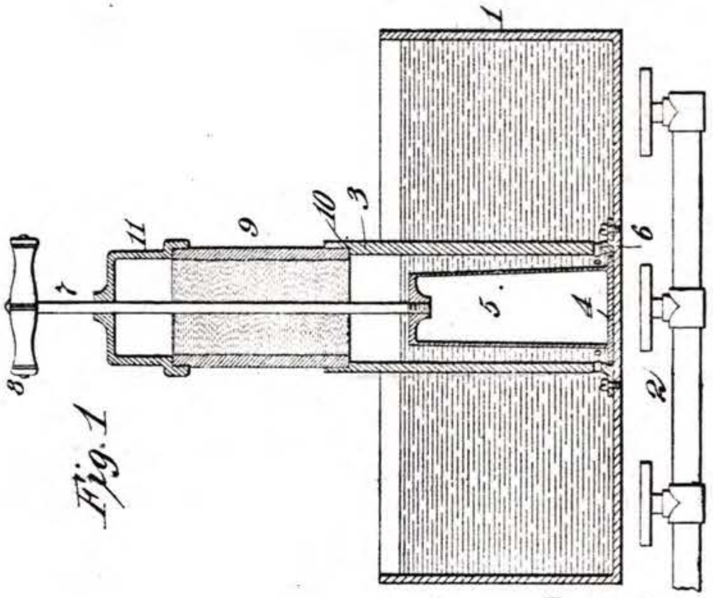


Fig. 1

**Witnesses:**

Jas. F. Coleman

Jno. R. Taylor

**Inventor**

Thomas A. Edison

by Dyer Edmonds & Dyer

Att'ys

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

## PROCESS OF DUPLICATING PHONOGRAPH-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 667,662, dated February 5, 1901.

Application filed May 8, 1900. Serial No. 15,874. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, county of Essex, and State of New Jersey, have invented a certain new and useful Improved Process of Duplicating Phonograph-Records, (No. 1,036,) of which the following is a specification.

My invention relates to an improved process for duplicating phonograph-records, and the process is of the character covered by my Patent No. 484,582, of October 18, 1892, wherein a matrix of an original record is employed as a mold for the making of the duplicates. In the specific process described in my previous patent the matrix secured from the original record is divided longitudinally, so as to form a sectional mold in which are cast the desired duplicates. My present invention is designed specifically as an improvement on said process, and my object is to provide a process wherein the production of the duplicate records will be facilitated and wherein the character of the resulting duplicates will be improved, since the mold used is continuous on its bore.

My present process depends upon the fact that after a molten metallic soap or a mixture of soaps or other suitable material has been introduced within a mold carrying the representation of a phonographic record in relief on its bore and allowed to set a sufficient contraction of the resulting duplicate can be secured as to permit of a longitudinal separation of the duplicate from the mold, whereby a continuous mold can be employed for the carrying on of the process.

In order that my invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a sectional view of a suitable apparatus for the purpose, illustrating the plunger and piston in their lowermost position; and Fig. 2, a similar view showing the same parts in their elevated positions.

In both the above views corresponding parts are represented by the same numerals of reference.

The apparatus illustrated in the figures is designed for the duplicating of cylindrical phonographic records, and it will be so described; but the applicability of my process for the duplication of other varieties of records will be apparent to those skilled in the art.

In the drawings, 1 represents a suitable jar or tank of the proper dimensions and made of any desired material. Within the jar or tank 1 I place the material of which the duplicate records are to be formed and which may be maintained in a molten condition by the application of heat in any way—as, for example, by a gas-tube 2, supplying a number of jets, as shown. The proper level of the molten material is indicated, and this level should be approximately maintained by the addition of fresh material from time to time within the tank as the liquid material may be withdrawn during the operation. The material in the tank 1 and of which the duplicate records are to be formed may be of any suitable character; but preferably it is a metallic soap or a combination of several soaps to which has been added a material not affected by water, such as ceresin, whereby the resulting duplicates will be protected from the effects of atmospheric moisture. Mounted within the tank and secured to its bottom is an open-ended cylinder 3, in which works a piston 4. A tapered core 5 is connected to or formed integrally with the piston 4, and said core is preferably hollow, so as to present a thin wall to the material, whereby the core will very quickly reach the temperature of the molten material when it is immersed therein. A number of openings 6 are formed in the cylinder 3, near the bottom thereof, below which openings the piston 4 passes in reaching its downward position, as shown in Fig. 1, whereby the liquid material may flow through said openings into the cylinder above the piston. Connected to the core 5 is a plunger 7, having an operating-handle 8. The connection between the core and plunger is such as will permit a separation of these parts, ordinary screw-threads being shown.

9 represents a mold which rests within a shoulder 10, formed at the top of the cylinder, and which mold carries on its bore the representation in negative or relief of a phonograph-record which it is desired to duplicate. This mold is preferably obtained by

the process described in my application for Letters Patent filed March 5, 1898, Serial No. 672,650, by first depositing upon the original record a suitable metal in the form of an infinitesimally-thin film by a process of vacuous deposit, by then electroplating or otherwise securing upon the film so obtained a sufficiently thick layer of the same or different metal, and by then properly backing up the metal so deposited or otherwise applied to the vacuous film either before or after the separation of the original record from the inclosing coating of metal either by contracting the record or by melting it out or in any other suitable way. The advantage of making a matrix or mold by first depositing upon an original phonograph-record a metal by a process of vacuous deposit is that an absolutely accurate copy in negative of such record will be produced irrespective of the fineness thereof. The mold 9 is preferably made of sufficient mass or thickness as to effectively chill the molten material when the latter is introduced therein, as I shall explain. Carried by the upper part of the mold is an inclosing cap 11, which may be secured onto the mold and which forms a bearing for the plunger 7.

In carrying out my improved process with an apparatus of this type I prefer to proceed substantially as follows: Molten material being placed within the tank or jar 1 is maintained in its liquid or fluid condition by the application of heat. The mold 9, being exposed to the atmospheric temperature, is relatively cold. The plunger 7 is first depressed, so as to force the piston 4 downward within the cylinder, ejecting the liquid material from beneath it, which material passes out through the openings 6. The bore of the cylinder 3 may, as shown, be slightly enlarged below the openings 6, so as to permit the piston 4 to pass beneath the same. As soon as the piston 4 passes below the openings 6 the molten or fluid material enters the cylinder above the piston, so as to fill the cylinder to the level of the liquid in the tank or jar. Owing to the thin wall of the core 5 the latter will almost immediately reach the temperature of the molten material, so that said core will not chill the latter. If a solid core is used, it will require to be immersed within or below the surface of the liquid material for a longer time to enable its temperature to reach that of the molten mass; but with this exception the process will be equally operative with a solid core as with a hollow core.

Assuming the hollow core to be used and that its temperature reaches that of the molten material almost immediately, the plunger 7 will be elevated, so as to carry the charge of molten material above the piston into the mold, as shown in Fig. 2, a greater or less excess of material passing above the mold into the cap 11. By employing the cap 11 it will be obvious that the level of the liquid material in the tank or jar may be varied considerably without affecting the operation. The liquid molten material entering the mold 9 will engage all portions of the record formed on the bore thereof, and the materially lower temperature of the mold will result in the almost instantaneous chilling of the surface of the molten material therein. In order to facilitate this surface-chilling of the liquid molten material entering the mold, the latter may be actually cooled by artificial means below atmospheric temperature—as, for instance, by the circulation of cold water through a water-jacket surrounding the mold or by a blast of cold air equably directed to all portions of the mold. The chilling of the surface of the molten material in the mold results in the setting of the positive impression thus secured from the negative record. The chilling of the molten material in the mold progresses toward the center, and any contraction in bulk will be compensated by the surplus material within the cap 11. As soon as the material within the mold has been chilled throughout the entire thickness thereof the material with the piston, core, cap, and plunger are removed from the cylinder, and the material is allowed to cool by exposure to a cold atmosphere or by an air-blast until the solidified material has contracted away from the bore of the mold, so as to permit it to be removed therefrom by forcing the plunger downward. The plunger is then removed from the core, and the latter is extracted from the cast duplicate, carrying the positive record on its periphery before the material has contracted sufficiently upon the core as to prevent this separation. Since the conductivity of heat from the material is effected slowly, the outer surface of the molded duplicate becomes hard and set, while the inner portion thereof next to the core is still in a relatively plastic condition, so that this separation of the core can with ordinary care be readily effected. The resulting duplicates thus secured after reaching the normal temperature are properly dressed at the ends and are reamed internally to the proper size, being then ready for use.

With records made by my process the contraction of the material radially to separate it from the mold is accompanied by a considerable longitudinal contraction following the instant when the surface is first set by the chilling effect of the mold and progressing until the material reaches the normal temperature, such shrinkage being approximately one per cent. with ordinary blanks. For this reason it is desirable that the original record from which the matrix is made is formed on a phonograph or allied talking-machine having a fewer number of threads on its feed-screw than the instrument on which the duplicates are finally used, in order that when the contraction has progressed to its finality the pitch of the record-thread on the duplicate will correspond to the pitch of the feed-screw of the reproducing-machine or approximately to that pitch, it being possible with modern reproducing apparatus to effect a satisfactory reproduction from a record, even when the pitch thereof differs slightly from that of the feed-screw of the machine. The pitch of the feed-screw of the machine on which the original record is made will differ from the pitch of the feed-screw of the machine on which the resulting duplicates are to be used to an extent depending upon the coefficient of contraction of the material used and will be determined by experiment with the material employed. It will be of course understood that after the mold has been removed from the cylinder and the separation of the cast duplicate is being effected therefrom a new mold and its accompanying parts may be inserted in place upon the cylinder, and the operations repeatedly carried on therewith.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. The process of duplicating cylindrical phonographic records, which consists in first making an original record with a spiral record-groove of greater pitch than that desired on the duplicate to be produced, then in making a hollow cylindrical matrix or mold from said original record, carrying the record in negative on its bore, and in finally making duplicate records from the matrix or mold by introducing therein and engaging therewith material maintained in an abnormally high temperature, whereby the cooling of such duplicate will contract the pitch of the record-groove, as and for the purposes set forth.

2. The process of duplicating phonographic records, which consists in securing a mold containing the record in negative on its bore, in introducing a molten material in the mold to receive a surface impression from such record, in allowing the molten material to set, in contracting the set material, and in separating the contracted molded material by a longitudinal movement, substantially as set forth.

3. The process of duplicating phonographic records, which consists in securing a mold having a record in relief in negative on its bore, in introducing a molten material in the mold around a core, in allowing the molten material to set, in contracting the set material, in removing the contracted material and the core from the mold, and in separating the core from the molded material, substantially as set forth.

4. The process of duplicating cylindrical phonograph-records, which consists in forming a cylindrical mold with a record in negative on its bore, in introducing a molten material in the mold to form a cylindrical duplicate, in allowing the duplicate to set, in contracting the duplicate, and in removing the contracted duplicate by a direct longitudinal movement, substantially as set forth.

5. The process of duplicating cylindrical phonograph-records, which consists in forming a cylindrical mold having the record in negative on its bore, in introducing molten material in the mold around a core, whereby a hollow cylindrical duplicate will be formed, in allowing the molten material to set, in contracting the molten material, and in withdrawing the contracted material from the mold by a direct longitudinal movement, substantially as set forth.

6. The process of duplicating cylindrical phonograph-records, which consists in forming a cylindrical mold carrying the record in negative on its bore, in introducing a molten material in the mold around a core, in allowing the material to set, in contracting the material, in withdrawing the contracted material and core from the mold, and in separating the core from the resulting duplicate, substantially as set forth.

7. The process of duplicating cylindrical phonograph-records, which consists in making a cylindrical mold carrying a record in negative on its bore, and of sufficient mass to produce a chilling effect on molten material introduced therein, then in introducing within the mold a molten material, the surface of which becomes chilled by contact with the mold, then in contracting the duplicate so formed, and finally, separating the duplicate from the mold by a direct longitudinal movement, substantially as set forth.

8. The process of duplicating cylindrical phonograph-records, which consists in securing a mold carrying a record in negative on its bore, and of sufficient mass to produce a chilling effect on molten material introduced therein, then in introducing within the mold around a core a molten material, the surface of which is chilled by contact with the mold, then in contracting the material, then in removing the contracted material and core from the mold, and in finally separating the core from the material, substantially as set forth.

9. The process of duplicating cylindrical phonograph-records, which consists in maintaining in a molten condition a mass of material from which the duplicates are to be made, in sustaining a mold over the mass of molten material, said mold carrying on its bore a record in negative, in successively elevating a part of the mass of molten material into the mold, in allowing such molten material within the mold to set, in contracting the set material, and in withdrawing the resulting duplicate from the mold by a direct longitudinal movement, substantially as set forth.

This specification signed and witnessed this 30th day of April, 1900.

THOS. A. EDISON.

Witnesses:
J. F. Randolph,
Frank L. Dyer.

No. 12,095. REISSUED MAR. 10, 1903.

# T. H. MACDONALD.
# PROCESS OF MAKING SOUND RECORDS.

APPLICATION FILED JAN. 22, 1903.

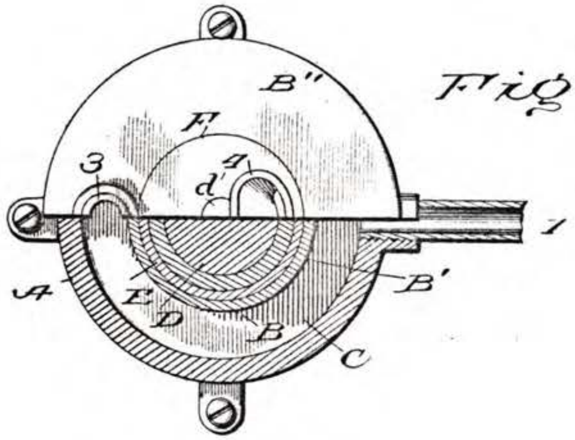


Fig. 2.

Fig. 1.

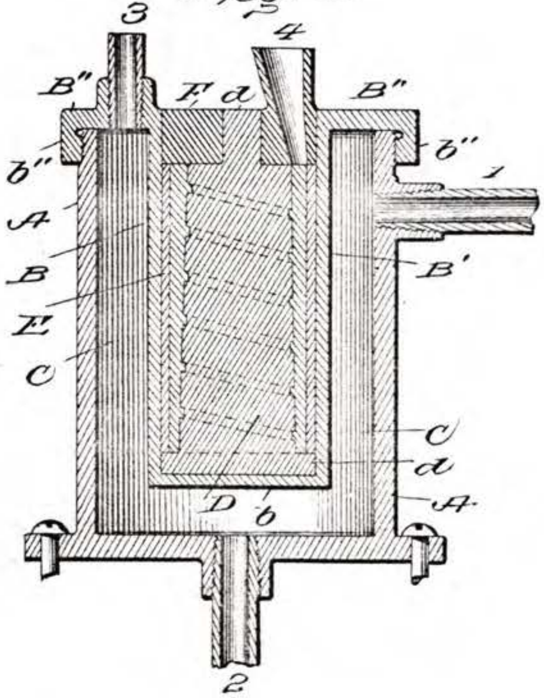
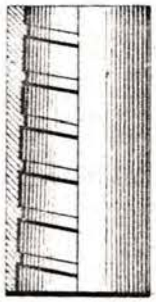


Fig. 3.



Inventor
Thomas H. Macdonald

Witnesses
Wm. B. Kerkam

By
Mauro, Cameron & Lewis
Attorneys

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF WASHINGTON, DISTRICT OF COLUMBIA.

## PROCESS OF MAKING SOUND-RECORDS.

**SPECIFICATION forming part of Reissued Letters Patent No. 12,095, dated March 10, 1903.**

Original No. 682,991, dated September 17, 1901. Application for reissue filed January 22, 1903. Serial No. 0,123.

*To all whom it may concern:*

Be it known that I, THOMAS H. MACDONALD, a resident of Bridgeport, Connecticut, have invented a new and useful Improvement in Processes of Making Sound-Records, which invention is fully set forth in the following specification.

This invention relates to improvements in sound-records and in the method of producing them by molding; and it consists in first superheating the material while in the mold and in then suddenly applying cold, whereby I obtain better results than heretofore possible.

The invention consists, further, in certain details to be hereinafter pointed out.

In order to explain my invention more readily, I refer to the annexed drawings, which show one form of apparatus for carrying out my process.

Figure 1 is a vertical sectional view; and Fig. 2 is a plan, partly broken away. Fig. 3 is intended to illustrate the improved sound-record.

The record is cast into a suitable mold, which is surrounded by a steam and water jacket for superheating and cooling the casting. This jacket consists of an outer shell A and an inner shell B for the mold, these shells inclosing between them the steam-tight space C. Shell A is closed at the bottom and open at the top for receiving shell B and is provided with valve-controlled inlets 1 and 2 for steam and cold water, respectively. Shell B consists of a hollow cylinder B', also closed at the bottom *b* and open at the top, and has an annular flange B'', that rests upon the top of shell A and is secured thereto, as by screw-threaded lip *b''*. Flange B'' constitutes the cover of the inclosed space C and serves to suspend shell B therein and is provided with the valve-controlled outlet 3. Core D has the base *d* fitting snugly in shell B' and resting on bottom *b*, and at its upper end carries the stem *d'*. A suitable matrix E is fitted snugly into shell B to rest upon base *d*. A head F is inserted in the top of shell B and rests squarely upon the top of matrix E and core D, stems *d'* taking into a suitable opening in the head, which thus assists in securing the core in proper position. The annular space between the matrix and the core (constituting the mold) is thus inclosed by the base *d* and the head F. The head is provided with the funnel 4, forming an inlet for pouring into the mold the melted material that is to form the improved sound-record.

In carrying out my invention I proceed as follows: I fill the mold (through funnel 4) with the melted material, (soap mixture or the like,) which is hereinafter for convenience designated "wax," though I do not limit myself to a wax-like composition, since any suitable material or composition that can be readily handled may be employed and will come within the scope of my invention. I then admit steam through inlet 1 into the space C and heat the mold and its contents up to, say, about 350° Fahrenheit and maintain the heat for some time, preferably until the entire mass of the wax is in a limpid state. This superheating forces out all air-bubbles from the mass of the wax and from the minute spaces in and around the irregularities in the matrix-surface, thus producing a more intimate relation between the molten wax and the matrix. After maintaining this heat for a length of time sufficient to drive off all bubbles and impurities I then admit cold water through inlet 2 and allow the steam to escape through outlet 3. This sudden application of cold chills the surface of the wax instantly and symmetrically and causes it to contract from the matrix-surface sufficiently to clear the now solidified casting from the matrix and permit its withdrawal. The fact that the cold acts evenly from all sides causes the contracting to be even and regular, so that cracking, &c., are avoided. Moreover, owing to the abnormal compression or concentration of the molten mass during the period of superheating and also to the subsequent enormous force of contraction due to the sudden chilling of its surface the sound-record molded by my process is much denser and harder on the surface than in case of an ordinary record made in the usual manner. It is, so to speak, "case-hardened" or tempered. Further, inasmuch as this symmetrical chilling effect takes place from the exterior of the mold and its casting I have discovered that with the composition at present employed (which is a mixture of two ingredients, as stearic acid and ceresin, both the hardness and the melting-point or solidifying-point of one ingredient being higher than those of the other) the first effect of this sudden exterior chilling is an initial reduction of the temperature to a point below the solidifying-point of the harder ingredient, which is thereupon converted into a thin shell or film, while the softer ingredient (still remaining liquid) is consequently forced inward. The result is as already indicated, viz: a casting whose exterior surface is much harder and denser than its mass, though the gradation is so gradual and imperceptible that there is no line of separation that might cause the outer casing to break off or the inner to shrink away.

Instead of admitting steam after the wax has been poured into the mold it may be admitted simultaneously or beforehand, as the object to be accomplished is the superheating of the molten mass and the maintaining of that heat. It is obvious that other means may be employed for superheating the material while in the mold.

Among the superior advantages of my case-hardened record so produced are that the mass being denser is less liable to be affected by changes of temperature and moisture and that being harder it is not so readily worn out by the action of a reproducing-stylus. Besides, while it would be difficult to engrave a satisfactory original sound-record upon a surface as hard as that produced by my process, yet by this process a sound-record equally as good as an original record is readily and cheaply produced in a more durable condition.

Of course I do not limit myself either to a cylindrical sound-record or to one of the type characterized by vertical irregularities, since the spirit of my invention consists in maintaining the molten wax (while in connection with its matrix) in a superheated condition and in then suddenly and symmetrically chilling it.

The record produced by the process herein described gives improved results in reproduction and is more durable than records made by direct engraving. In the latter the surface over which the reproducer-point rubs in reproducing is made by a cutting or scraping instrument having a blunt edge. When this surface is examined under a magnifying-glass, it is seen to be roughly broken, the molecules of wax having been disturbed and their adhesion to one another weakened. The reproducing-stylus rubbing over such a surface detaches these projecting particles, further roughening the surface and causing scratching sounds in the reproduction. On the other hand, the surface of the molded record being formed by the cooling of melted particles strongly adherent one to another offers far greater resistance to roughening by the reproducer. Such records therefore have longer life than those made in the ordinary way.

The improved sound-record resulting from the process herein described is claimed in a divisional application filed May 21, 1901, Serial No. 61,267.

Having thus described my invention, I claim—

1. The process of molding sound-records which consists in filling a suitable matrix with a suitable composition, maintaining the same for a length of time in a superheated condition, and then suddenly and symmetrically chilling it, substantially as described.

2. The process of making a sound-record, which consists in pouring a suitable melted material into a suitable matrix-mold, then admitting steam into a jacket surrounding said matrix and continuing this step until the said material has become limpid and impurities are driven off and the said material forced into intimate contact with its matrix, then allowing the steam to escape and admitting cold water into the jacket whereby the said material is suddenly and symmetrically chilled from its exterior surface next its matrix, substantially as and for the purpose set forth.

3. The process of molding sound-records which consists in filling a suitable matrix with a suitable material and maintaining the same for a length of time in a superheated condition, and then suddenly and symmetrically chilling the same from the exterior inward, substantially as and for the purpose described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
M. A. Fogo,
A. B. Keough.

No. 12,096. REISSUED MAR. 10, 1903.

# T. H. MACDONALD.
## SOUND RECORD.
APPLICATION FILED JAN. 22, 1903.

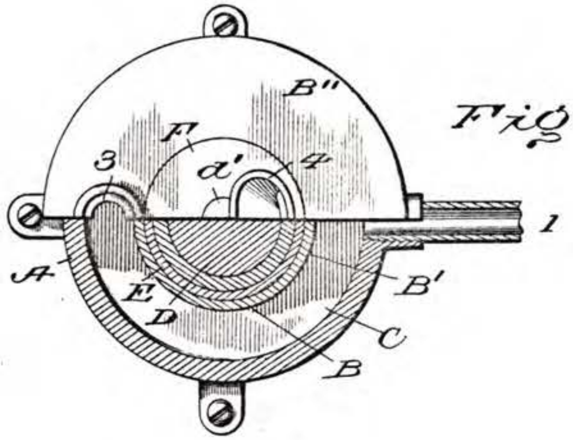


Fig. 2.

Fig. 1.

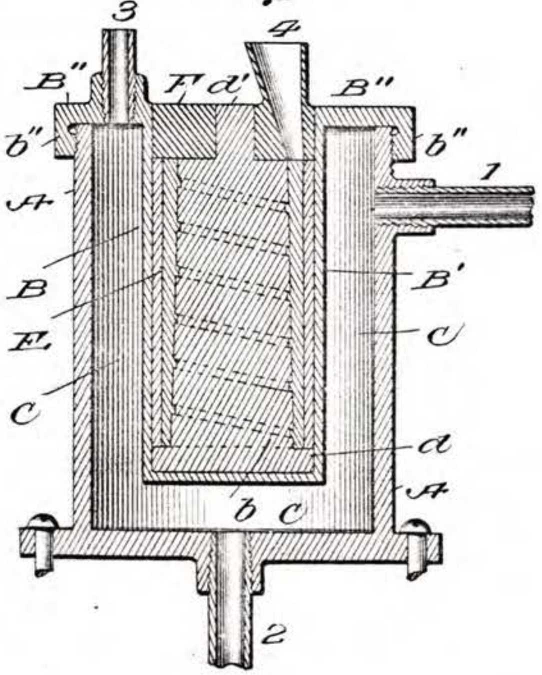
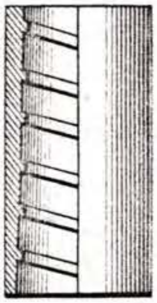


Fig. 3.



Inventor
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Witnesses
Jw Imrie
Wm B Kerkam

By Mauro, Cameron Lewis
Attorneys

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF WASHINGTON, DISTRICT OF COLUMBIA.

## SOUND-RECORD.

**SPECIFICATION** forming part of Reissued Letters Patent No. 12,096, dated March 10, 1903.

Original application filed November 3, 1900, Serial No. 35,351. Divided and application filed May 21, 1901, Serial No. 61,267.
Patented September 17, 1901, No. 682,992. Application for reissue filed January 22, 1903. Serial No. 140,124

*To all whom it may concern:*

Be it known that I, THOMAS H. MACDONALD, a resident of Bridgeport, Connecticut, have invented a new and useful Improvement in Sound-Records, which invention is fully set forth in the following specification.

This invention relates to an improvement in sound-records; and it consists in the improved record itself, this application being a division of my application, filed November 3, 1900, Serial No. 35,351.

In order to explain my invention more readily, I refer to the annexed drawings, which show one form of apparatus for carrying out my process.

Figure 1 is a vertical sectional view, and Fig. 2 a plan partly broken away. Fig. 3 is intended to illustrate the improved sound-record.

The record is cast into a suitable mold which is surrounded by a steam and water jacket for superheating and cooling the casting. This jacket consists of an outer shell A and an inner shell B for the mold, these shells inclosing between them the steam-tight space C. Shell A is closed at the bottom and open at the top for receiving shell B and is provided with valve-controlled inlets 1 and 2 for steam and cold water, respectively. Shell B consists of a hollow cylinder B′, also closed at the bottom $b$ and open at the top and has an annular flange B″, that rests upon the top of shell A and is secured thereto, as by screw-threaded lip $b''$. Flange B″ constitutes the cover of the inclosed space C and serves to suspend shell B therein and is provided with the valve-controlled-outlet 3. Core D has the base $d$ fitting snugly in shell B′ and resting on bottom $b$ and at its upper end carries the stem $d'$. A suitable matrix E is fitted snugly into shell B to rest upon base $d$. A head F is inserted in the top of shell B and rests squarely upon the top of matrix E and core D, stems $d'$ taking into a suitable opening in the head, which thus assists in securing the core in proper position. The annular space between the matrix and the core (constituting the mold) is thus inclosed by the base $d$ and the head F. The head is provided with the funnel 4, forming an inlet for pouring into the mold the melted material that is to form the improved sound-record.

In carrying out my invention I proceed as follows: I fill the mold (through funnel 4) with the melted material, (soap mixture or the like,) which is hereinafter for convenience designated "wax," though I do not limit myself to a wax-like composition, since any suitable material or composition that can be readily handled may be employed and will come within the scope of my invention. I then admit steam through inlet 1 into the space C and heat the mold and its contents up to, say, about 350° Fahrenheit and maintain the heat for some time, preferably until the entire mass of the wax is in a limpid state. This superheating forces the melted wax into a more intimate relation with the matrix and expels all air-bubbles from the mass of the wax and from the minute spaces in and around the irregularities in the matrix-surface, thus producing a more intimate contact between the molten wax and the matrix. After maintaining this heat for a length of time sufficient to drive off all bubbles and impurities I then admit cold water through inlet 2 and allow the steam to escape through outlet 3. This sudden application of cold chills the surface of the wax instantly and symmetrically and causes it to contract from the matrix-surface sufficiently to clear the now-solidified casting from the matrix and permit its withdrawal. The fact that the cold acts evenly from all sides causes the contracting to be even and regular, so that cracking, &c., are avoided. Moreover, owing to the abnormal compression or concentration of the molten mass during the period of superheating and also to the subsequent enormous force of contraction due to the sudden chilling of its surface the sound-record molded by my process is much denser and harder on the surface than in case of an ordinary record made in the usual manner. It is, so to speak, "case-hardened" or tempered. Further, inasmuch as this symmetrical chilling effect takes place from the exterior of the mold and its casting I have discovered that with the composition at present employed (which is a mixture of two ingredients, as stearic acid and ceresin, both the hardness and the melting-point or solidifying-point of one ingredient being higher than those of the other) the first effect of this sudden exterior chilling is an initial reduction of the temperature to a point below the solidifying-point of the harder ingredient, which is thereupon connected into a thin shell or film, while the softer ingredient (still remaining liquid) is consequently forced inward. The result is as already indicated—viz., a casting whose exterior surface is much harder and denser than its mass, though the gradation is so gradual and imperceptible that there is no line of separation that might cause the outer casing to break off or the inner to shrink away.

Instead of admitting steam after the wax has been poured into the mold it may be admitted simultaneously or beforehand, as the object to be accomplished is the superheating of the molten mass and the maintaining of that heat. It is obvious that other means for superheating the material may be employed.

Among the superior advantages of my case-hardened record so produced are that the mass being denser is less liable to be affected by changes of temperature and moisture and that being harder it is not so readily worn out by the action of a reproducing-stylus. Besides, while it would be difficult to engrave a satisfactory original sound-record upon a surface as hard as that produced by my process, yet by this process a sound-record equally as good as an original record is readily and cheaply produced in a more durable condition.

Of course I do not limit myself either to a cylindrical sound-record or to one of the type characterized by vertical irregularities.

I claim—

1. A sound-record of suitable composition having the surface of the undulatory record case-hardened or tempered, substantially as described.

2. A sound-record of suitable material having its surface case-hardened or tempered and graduating inward into a comparatively softer mass by imperceptible degrees, substantially as described.

3. A molded sound-record of suitable composition having the surface of the undulatory record case-hardened or tempered.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
M. A. FOGO,
A. B. KEOUGH.

(No Model.)

# T. H. MACDONALD.

## DEVICE OR APPARATUS FOR DUPLICATING GRAPHOPHONE RECORDS.

No. 559,806. Patented May 12, 1896.

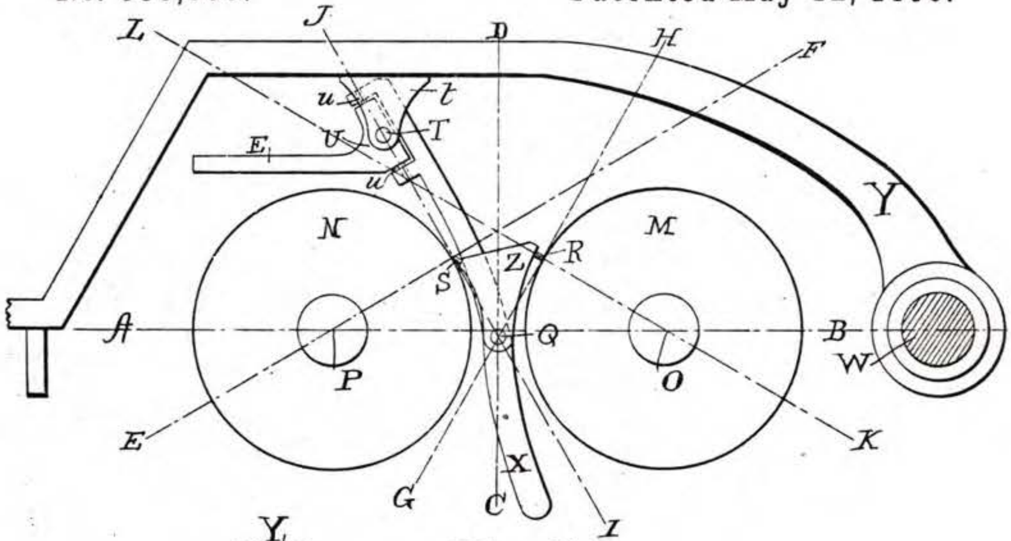


*Fig.1.*

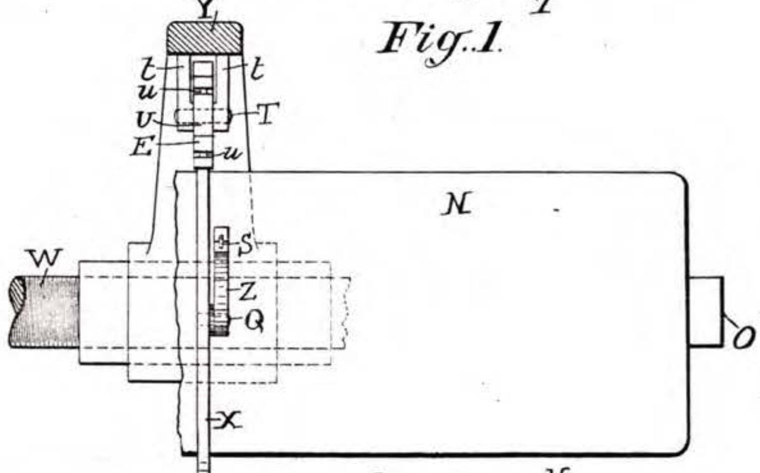


*Fig 2.*

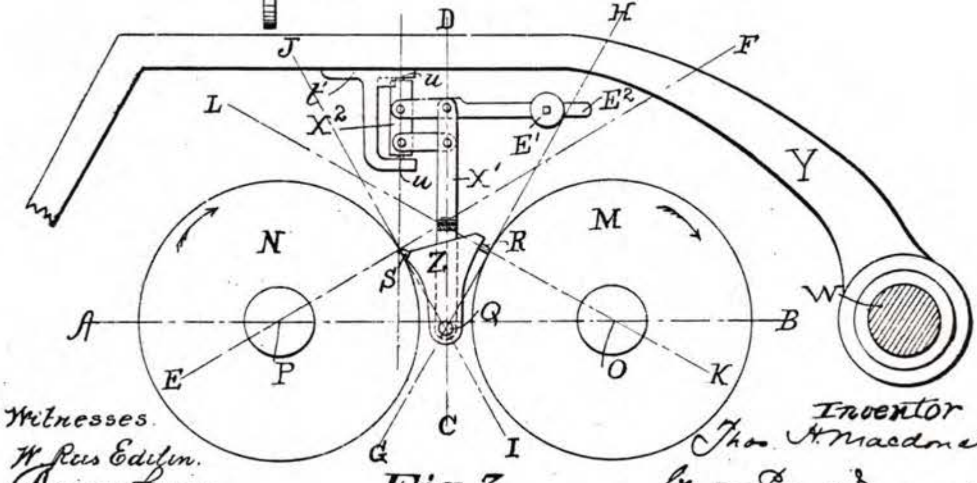


*Fig. 3.*

Witnesses.
W. Rees Edelin.

Inventor
Thos. H. Macdonald
by Pollok & Mauro
his attorneys

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO
THE AMERICAN GRAPHOPHONE COMPANY, OF WEST VIRGINIA.

## DEVICE OR APPARATUS FOR DUPLICATING GRAPHOPHONE-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 559,806, dated May 12, 1896.

Application filed December 4, 1895. Serial No. 571,083. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS H. MACDONALD, of Bridgeport, Connecticut, have invented a new and useful Improvement in Devices or Apparatus for Duplicating Graphophone-Records, which is fully set forth in the following specification.

This invention has reference to devices or apparatus for duplicating graphophonic records. In such apparatus as heretofore constructed the reproducing and recording styles have usually been carried by separate levers connected by suitable intermediate links, diaphragms, &c., the pressure requisite to cut the duplicate record being transmitted through the pivot-points of the levers by suitable weights or other equivalent means. Such devices not only require very painstaking adjustment, but owing to their delicacy of structure are very susceptible to injury.

The object of my present invention is to provide a much simplified construction of a substantial character and which will duplicate records with greater precision than the duplicating devices heretofore in use. In accordance therewith the reproducing and recording styles are rigidly connected, both being carried by a lever to which vibratory movements are imparted by the master record and whereby the reproducing-style is caused to cut in a blank a duplicate corresponding to the master record. This lever is pivoted to an arm, which is arranged (at an inclination or otherwise) so that the weight thereof falls upon the point of pivot to hold the styles in contact with their respective cylinders. Said arm, which may for distinction be called the "pressure-arm," is pivoted at one end to swing therefrom and is also swiveled, permitting movement about a longitudinal axis. The pressure exerted by the pressure-arm may and is preferably counteracted to some extent by a weight operating from the pivot-point of said arm, thus permitting the latter to be made much heavier and more substantial and giving it greater inertia than would otherwise be permissible with a device of this general construction. As the blank cylinder revolves against the cutting-point of the recorder a groove is cut in its surface exactly corresponding to that of the master record, the reproducing-point following and accurately transmitting to the recorder the movements due to variations in the depth of cut of the master record. The recording-point is in the line of the axis on which the pressure-arm is swiveled longitudinally, so that the reproducing-point can find its adjustment accurately without disturbing the position of the recorder.

Details of arrangement and what is considered the best embodiment of my invention in an operative machine will be clearly understood by reference to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a cross-section of an apparatus embodying the invention; Fig. 2, an elevation, partly in section; and Fig. 3, a view similar to Fig. 1, illustrating another form of apparatus embodying the invention.

Referring to Figs. 1 and 2, Y represents a traveling supporting-arm engaging a feed-screw W at one end and sliding on a rail V at its other end. M is the master-record cylinder, and N the blank cylinder for receiving the duplicate, said cylinders being horizontally arranged parallel to each other and carried by suitable mandrels connected with and driven at the same speed by suitable mechanism in a well-known manner. Z is a lever carrying the reproducing-point R and the recording-point S. This lever is pivoted at Q to pressure-lever X, arranged at an inclination and swiveled upon the pins *u u*, projecting into sockets in a block U to turn about a longitudinal axis. The block U, carrying a weighted arm E, counteracting to some extent the pressure exerted by the lever X upon the points R and S, is pivoted at T to a bifurcated bracket *t*, depending from the arm Y. The weighted lever or pressure-arm X is thus pivoted at T to swing in a plane at right angles to the axis of the record-cylinders and on the points *u* to oscillate slightly on an axis tangent to cylinder N.

To state with geometrical precision that relation and arrangement of the parts which has in actual practice been found to produce the best results, but to which the invention is not limited, it is preferable to locate the pivot-point Q of lever Z at the intersection of two corresponding tangent lines I J and G H, said point of intersection being near a horizontal line A B, projected through the axes O and P of the cylinders M and N, while the recording and reproducing points S and R bear against the cylinders at the respective tangent points of the said lines I J and G H. The swivel-pins *u u* are also in the tangent line I J in which the recording-point is located, so that the oscillating movement of the arm X is about the line I J as an axis. Consequently the reproducing-point R can find a lateral adjustment without affecting the position of the recording-point S. It will be noted that the pivot-points T and Q and the swivel-points *u u* are all in line with the recording-point S, the object of this disposition being to prevent distortion.

From the foregoing description it will be understood that the weight of arm X, swinging from pivot-point T and acting upon fulcrum Q of lever Z, supplies the pressure in the direction of line C D for holding the points R and S in contact with the cylinders M and N, which pressure it is found desirable for the reasons indicated to counteract to some extent by the weight E. Thus as the cylinders rotate in the direction of the arrows the variations in depth of the master record cause the point R to move in the direction of the radial line L K of cylinder M, vibrating the lever Z on the pivot Q, and in turn imparting movements to the point S in the direction of the radial line E F of cylinder N, and thereby causing it to cut a record in the blank N exactly corresponding to the master record.

Referring now to Fig. 3, the lever or support Z for the recording and reproducing points is, as before, pivoted at Q to a pressure-arm $X'$, the point Q being at the intersection of the two tangent lines I J and G H, drawn from the respective points of contact of the recorder and reproducer with cylinders M N. Arm or lever $X'$ is depressed by the counterweight $E'$, adjustable on lever $E^2$. In order to secure parallelism of movement of lever $X'$, it is made part of a pantograph system, the parallel arm $X^2$ being swiveled at points *u u* in the bracket $t'$, so as to permit a slight oscillation, as in the arrangement shown in Fig. 1. This axis of oscillation is in a line which intersects recording-point S. The operation of the apparatus shown in Fig. 3 is substantially as already described with reference to Figs. 1 and 2.

The disposition and arrangement of the several parts have been described with minuteness of detail for the purpose of exhibiting the invention in the best practical forms known to me.

It will be obvious to skilled mechanics that these details may be varied within wide limits without departing from the spirit of the invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A device for duplicating graphophone-records comprising, in combination, a lever mounted to vibrate between a master record and a blank, a reproducing and a recording style carried by said lever, and means for applying pressure to the lever whereby said styles are respectively maintained in contact with the master record and blank, substantially as described.

2. A duplicating apparatus comprising, in combination, a support mounted to vibrate between a master record and a blank, a reproducing and a recording style secured rigidly to said support, and a pivoted pressure-arm carrying the fulcrum of the support and holding the styles with yielding pressure respectively in contact with the master record and blank, substantially as described.

3. In a graphophonic duplicating device, the combination with a suitable support, of a lever carrying the reproducing and recording styles, said lever being mounted to have a vibratory movement between a master record and a blank, and an oscillatory movement on an axis intersecting the point of the recording-style, substantially as described.

4. In a duplicating device, the combination with a supporting-arm, of a lever carrying the reproducing and recording styles and mounted to vibrate between the master record and blank, a pressure-arm pivotally supported from said supporting-arm, carrying the fulcrum of said lever, and swiveled to oscillate slightly about a longitudinal axis, substantially as described.

5. A duplicating apparatus comprising in combination a lever carrying the reproducing and recording styles, and mounted to vibrate between the master record and blank, and a pivotally-supported weighted arm carrying the fulcrum of the lever and swiveled to oscillate about a longitudinal axis passing through the recording-style and the fulcrum of the lever, substantially as described.

6. In a duplicating apparatus, the combination of a lever carrying the reproducing and the recording styles and mounted to vibrate between the master record and blank, a pivoted weighted arm carrying the fulcrum of said lever, and means for partially counteracting the weight of said arm, substantially as described.

7. In a duplicating apparatus, the combination with a supporting-arm, of a pivoted lever carrying the reproducing and recording styles and mounted to vibrate between the master record and the blank, a block pivotally connected to said supporting-arm, a weighted pressure-arm swiveled to said block and carrying the pivot of the lever, and a weighted arm on the block acting to partially counteract the pressure of the arm, substantially as described.

8. In a duplicating apparatus, the combination of the weighted pressure-arm, a lever fulcrumed thereon between the master record and blank, a reproducing-point and a record-

ing-point pressed by the weight of said arm into contact with the said master record and blank, respectively, the fulcrum of said lever being at the intersection of tangent lines drawn respectively from the points of the recorder and reproducer, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
G. L. HUBBELL,
CLEMENT MARCH.

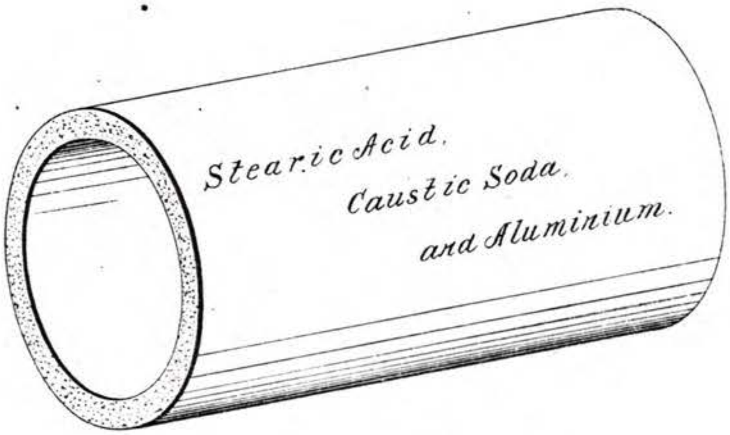
**No. 606,725.** **Patented July 5, 1898.**

**T. H. MACDONALD.**

**MANUFACTURE OF GRAPHOPHONE TABLETS.**

(Application filed Nov. 27, 1896.)

**(No Model.)**



Witnesses.
W. R. Edelen
Amos Lewis.

Inventor.
Thomas H. Macdonald.
by Pollok & Mauro.
his attorneys.

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF WASHINGTON, DISTRICT OF COLUMBIA.

## MANUFACTURE OF GRAPHOPHONE-TABLETS.

**SPECIFICATION** forming part of Letters Patent No. 606,725, dated July 5, 1898.

Application filed November 27, 1896. Serial No. 613,615. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS H. MACDONALD, of Bridgeport, Connecticut, have invented new and useful Improvements in the Manufacture of Graphophone-Tablets, which improvements are fully set forth in the following specification.

This invention relates to the manufacture of tablets or blanks adapted to receive engraved records of sounds, and more particularly to the composition of matter of which the tablet is composed.

The recording material in order to answer well the requirements of the engraving method of recording sounds should be perfectly amorphous, slightly cohesive, and capable of being removed cleanly and smoothly in chips or shavings under the action of the recording-stylus when actuated by the feeble force of sound-waves. The material, moreover, should be sufficiently hard to withstand ordinary handling, to retain perfectly its form, and to resist the effect of ordinary changes of temperature. It should also be a stable compound or material in order that records made in it may be preserved for indefinite lengths of time.

As pointed out in Letters Patent No. 341,214, granted May 4, 1886, to C. A. Bell and S. Tainter, the properties above indicated reside in a greater or less degree in wax and wax-like substances—such as beeswax, paraffin, stearin, &c.—though by special preparation of these and similar substances their fitness for the purpose in view has been increased.

It has been heretofore proposed to use as a sound-recording material an insoluble soap made by saponification of any fatty acid by means of an earthy alkali, such as lime. It has also been proposed to employ a metal, such as lead, combined with stearic or oleic acid, and particularly a mixture of oleate and stearate of lead; but tablets made of insoluble lime-soap or of stearates or oleates of lead have never yielded commercially-successful results. Several practical difficulties have been encountered in endeavoring to make tablets composed wholly or in part of soap. The chief difficulty has been that the surfaces of such tablets become coated after a greater or less length of time with a bluish film having the appearance of mold and which has been termed "efflorescence." This is due to the presence in the material of hygroscopic compounds, which on being attacked by moisture work out to and spread upon the surface of the tablet.

I have found that lead in any form, as well as most of the salts of other metals which might be otherwise suitable for the purpose in view, give rise to hygroscopic compounds. This is particularly true of stearates and acetates of lead. Another difficulty that arises is the formation of crystalline or crystallizable compounds in the operation of making soap. The object of introducing a metal (or metallic salt) is to prevent all tendency to crystallization, it being of the first importance to secure a composition which shall be and under all conditions remain perfectly amorphous and presenting equal resistance to cutting in every direction. All ordinary commercial soaps have this tendency to crystallization in some degree, it not being possible to introduce sufficient sodium or soda salt to prevent all crystallization.

The accompanying drawing illustrates a common form of tablet for use in receiving engraved records of sounds.

In carrying out my invention, whereby all the conditions herein pointed out as essential are secured, I take stearic acid as nearly pure as can be obtained and convert it into soda soap in the manner hereinafter explained. The composition, however, differs from ordinary soap in that it contains no oleates, I having found that the presence of even a small quantity of oleate or oleic acid is detrimental. It is also important that the tallow or other source from which the stearic acid is obtained be completely deglycerinized. Except under these conditions the result will be unsatisfactory.

In converting the stearic acid into soap I produce only a partial saponification—that is to say, instead of using the chemical equivalent in caustic alkali of the fat acid I use about forty per cent. of that quantity of alkali-thus producing what may be called a soap of about two-fifths saponification. This is the proportion which gives the best results, but is of course variable within limits. The controlling consideration is that the greater the quantity of alkali the higher will be the melting-point of the resulting soap, and a complete saponification will produce a soap which requires to melt at a temperature which will char it. As the material is to be molded into cylindrical or other forms, it must be capable of melting at a moderate temperature, say between 250° and 330° Fahrenheit. On the other hand, if the saponification be not carried far enough the material will be too soft and will run at a lower temperature than is desired. In this soap I have incorporated aluminium, which I have found to be the metal best suited in all respects for the purpose. This may be used in the form of aluminic hydrate or in the metallic state, powdered, or in small ingots. The method of introducing the metal is, moreover, important, owing to the tendency of sodium and aluminium when combined to form crystallizable compounds. Preferably the metal is first added to the soda-lye, forming with a portion thereof aluminate of soda, (sodium-ortho-aluminate,) which readily unites with the stearic acid subsequently added. The quantity of aluminium employed is relatively very small.

In order that the invention may be fully understood, I will give two formulas which have yielded the best results obtained.

Formula A: Stearic acid, free from oleic acid and glycerin, four hundred and eight pounds; aluminic hydrate, seven pounds; caustic-soda lye, eighty-five pounds. To this is added, for the purpose of "tempering," paraffin, ozokerite, or similar material, seventy-two pounds. The caustic soda is incorporated in water until a lye of 37.5° Baumé is obtained, and this is heated to its boiling-point, about 242° Fahrenheit. The aluminic hydrate is added and is quickly taken up by the lye. The stearic acid is melted and raised to about the same temperature and the compound of lye and aluminium added slowly thereto. It will unite readily therewith. It is preferred to employ about the temperature indicated, as thereby the formation of the composition proceeds gradually and without violent ebullition. The temperature may subsequently be raised to about 300° Fahrenheit and continued at that heat until the water is all expelled. The composition is now completed except for the addition of a material such as paraffin, ozokerite, or ceresin to bring it to the desired degree of hardness.

Formula B: Stearic acid, three hundred pounds; powdered aluminium, 1.5 pounds; caustic-soda lye, 37.5° Baumé, nine pounds; sal-soda dissolved in twelve gallons of water, sixty pounds; ceresin, sixty pounds. The sal-soda lye and caustic-soda lye may be united before the aluminium is added, or the latter may be added to the caustic soda and the two liquids then united. Instead of powdered aluminium I may use ordinary ingot-aluminium with results nearly if not equally as good. After the material is molded to the desired form it should be quickly cooled to ordinary temperatures.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The process of making a sound-recording material, by dissolving aluminium in soda-lye, and adding the solution to stearic acid, substantially as described.

2. The process of making a sound-recording material by melting stearic acid, free from glycerin and oleates, adding thereto soda-lye and aluminium, and heating the mass, substantially as described.

3. In the process of making a sound-recording material, the improvement consisting in adding to stearic acid soda-lye with which a metal such as aluminium has been united in such quantity as to produce partial saponification, and heating the mixture, substantially as described.

4. The process of making a sound-recording material by treating stearic acid with soda-lye in quantity sufficient to produce about a forty-per-cent. saponification, the lye containing a metal and heating the mixture, substantially as described.

5. The process of making a sound-recording material by forming a soda-lye, heating to about its boiling-point, adding a small quantity of aluminium thereto, heating pure stearic acid to about the same temperature, adding the compound of lye and aluminium and continuing the heating until the moisture is expelled, substantially as described.

6. The process of making a graphophone-tablet by forming a soda-lye, heating to about its boiling-point, adding a small quantity of aluminium thereto, heating pure stearic acid to about the same temperature, adding the compound, continuing the heating until the moisture is expelled, molding into the desired shape and then quickly cooling, substantially as described.

7. The process of making a sound-recording material, by partial saponification of stearic acid with soda-lye having aluminium united therewith, substantially as described.

8. The process of making a sound-recording material, by adding aluminic hydrate to caustic-soda lye, adding the compound to melted stearic acid, and heating the mixture, substantially as described.

9. The process of making a sound-recording material, by adding aluminium to soda-lye, adding the same to stearic acid, heating the mixture, and adding a softening material such as paraffin, substantially as described.

10. A composition of matter for a sound-recording tablet formed of pure stearic acid (free from oleic acid and glycerin) partly

saponified by caustic soda, and having aluminium incorporated therein, substantially as described.

11. The process of making a sound-recording material by adding aluminate of soda to stearic acid and heating the mixture, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
S. T. CAMERON,
REEVE LEWIS.

# UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF WEST VIRGINIA.

## PROCESS OF MAKING GRAPHOPHONE-BLANKS.

**SPECIFICATION** forming part of Letters Patent No. 626,709, dated June 13, 1899.

Application filed August 23, 1898. Serial No. 689,351. (No specimens.)

*To all whom it may concern:*

Be it known that I, THOMAS H. MACDONALD, of Bridgeport, Connecticut, have invented a new and useful Improvement in Graphophone-Tablets and Processes of Manufacturing the Same, which improvement is fully set forth in the following specification.

My invention relates to the art of manufacturing blanks or tablets upon which sound-records may be cut or engraved, and more particularly to the process of treating the composition of matter of which the tablet is composed to the end that the same may be perfectly amorphous, free from all fibrous or other organic impurities, and without tendency to crystallization.

In forming a sound-record the method described in United States Patent No. 341,214 is now commonly employed, which method consists in cutting or engraving an undulatory groove in the surface of a suitable tablet by means of a cutting-style attached to a vibratory diaphragm upon which the sounds to be recorded are allowed to impinge. The force of the sound-waves is very weak, and it is essential to the accomplishment of the best results that the surface of the tablet should be such as to enable the style to cut a smooth undulatory line whose undulations shall correspond exactly to those of the recorded sound-waves. If there is any crystalline formation or any tendency thereto in the surface of the material composing the tablet, the shaving removed by the style is liable to follow the line of cleavage of the crystal, thus offering variable resistance to the action of the style and producing a groove whose irregularities do not correspond exactly to the undulations of the recorded sound-waves. It is also very important that the composition of matter composing the tablet should be free from all fibrous or other organic matter, as such offers uneven resistance to the cutting action of the style, causing it to form a rough and inaccurate record. In some cases the style rides over the fiber and makes no record at all, causing what is known as "blind spots." In other cases the style fails to cut the fiber, but pulls it out bodily, leaving a hole or depression where there should have been a smooth cut. Again, the style, instead of cutting the fiber or removing it bodily, tears through it, leaving rough jagged ends which when the rubbing-style of a reproducer rubs over them give a rough harsh quality to the reproduced sound. Moreover, the organic matter is liable to ferment and mildew, greatly lessening the value of the blank and destroying the record cut therein.

In my Patent No. 606,725, dated July 5, 1898, I have described and claimed a process for making blank tablets whereby a superior tablet may be produced which is to a large extent lacking in the objectionable features above described and upon which records of a high order of merit may be produced. I have found, however, that there is often a tendency to form crystals upon the surface of blanks made by such process, which tendency is due to the presence in the blank of the "water of crystallization." I have also learned that such tablets sometimes contain fibrous or other organic impurities, such as fine dust particles, which are at all times floating in the air and which the most vigilant care could not entirely exclude.

The object of the present invention is to produce a blank tablet which shall be without any tendency to crystallization and in which all fibrous matter shall be destroyed; and to this end the invention consists in subjecting the composition of matter which is to constitute the tablet to a degree of heat sufficient to entirely drive off all water of crystallization and entirely destroy all fibrous and other organic impurities in the composition of matter.

Heretofore in the treatment of the composition of matter of which the tablets were to be formed heat has been resorted to for the purpose of eliminating the water; but great care has been taken not to exceed a temperature of about 330° Fahrenheit for fear of "charring" the composition and thereby rendering it unfit for use as a tablet material. This temperature was not sufficient to entirely eliminate the water of crystallization and would not destroy fibrous and other organic matter. I have discovered, however, that the composition of matter may be advantageously subjected to a heat of from 450° to 475° Fahrenneit, and that by so doing the water of crystallization may be entirely eliminated and the fibrous and other organic impurities eliminated or disintegrated.

For the purpose of illustrating my invention and the best method known to me for putting the same into practice I will describe one composition of matter and the process of forming and treating the same preparatory to molding it into tablet form.

Formula: Stearic acid, free from oleic acid and glycerin, four hundred and eight pounds; aluminic hydrate, seven pounds; caustic-soda lye, eighty-five pounds. To this is added for the purpose of "tempering" paraffin, ozocerite, or similar material, seventy-two pounds. The caustic soda is incorporated in water until a lye of 37.5° Baumé is obtained, and this is heated to its boiling-point, about 242° Fahrenheit. The aluminic hydrate is added and is quickly taken up by the lye. The stearic acid is melted and raised to about the same temperature, and the compound of lye and aluminium slowly added thereto. It will unite readily therewith. It is preferred to employ about the temperature indicated, as thereby the formation of the composition proceeds gradually and without violent ebullition. The temperature of the molten mass is then raised to a point somewhere between 450° and 475° Fahrenheit. When the desired temperature has been reached, I allow the same to fall about 100° and then pour the mass into the molds in the usual manner. The fall of the temperature may be conveniently secured by putting out the fire and allowing the mass to stand a few moments.

It is not, of course, essential that all the ingredients constituting the compound material should first be incorporated in the mixture before heating the same to the high temperature required to drive off the water of crystallization and destroy all organic matter, as the ingredients may, if it is found advantageous, be heated separately to the high degree necessary, or partial combinations may be formed, these heated to a high degree, and then the partial combinations united to form the finished compound. I prefer, however, to first incorporate and thoroughly unite all the ingredients forming the compound and then raise the entire mass to the high degree of heat necessary to drive off the water of crystallization and disintegrate the fibers and similar impurities, as hereinbefore described.

Not only do the blanks thus produced stand extremes of heat and cold better without molding or cracking, but they give better results at all times on account of their being more nearly amorphous and homogeneous.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In the process of making a sound-recording material, the improvement consisting in partially saponifying stearic acid, and then heating the mass to a temperature of about 460° Fahrenheit, substantially as described.

2. In the process of making a sound-recording material, the improvement consisting in mixing stearic acid with caustic-soda lye, and then heating the mass to about 460° Fahrenheit.

3. The improvement in the process of making sound-recording material which consists in heating such material to about 460° Fahrenheit, then cooling the same down to about 360° Fahrenheit, and then molding the material into the desired shape, substantially as described.

4. The process of making a sound-recording material consisting in dissolving aluminium in soda-lye, adding the solution to stearic acid, and raising the temperature of the mass to about 460° Fahrenheit, substantially as described.

5. The process of making a sound-recording material, said process consisting in adding to stearic acid soda-lye with which a metal has been united, the lye being in such quantity as to produce partial saponification, and heating the mixture to about 460° Fahrenheit, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:

HENRY A. HUBBELL,
E. W. SULHIE.

**No. 682,991.** **Patented Sept. 17, 1901.**

## T. H. MACDONALD.

## PROCESS OF MAKING SOUND RECORDS.

(Application filed Nov. 3, 1900.)

(No Model.)

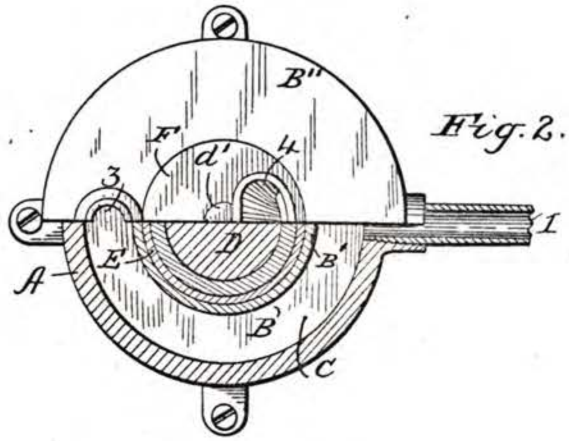


*Fig. 2.*

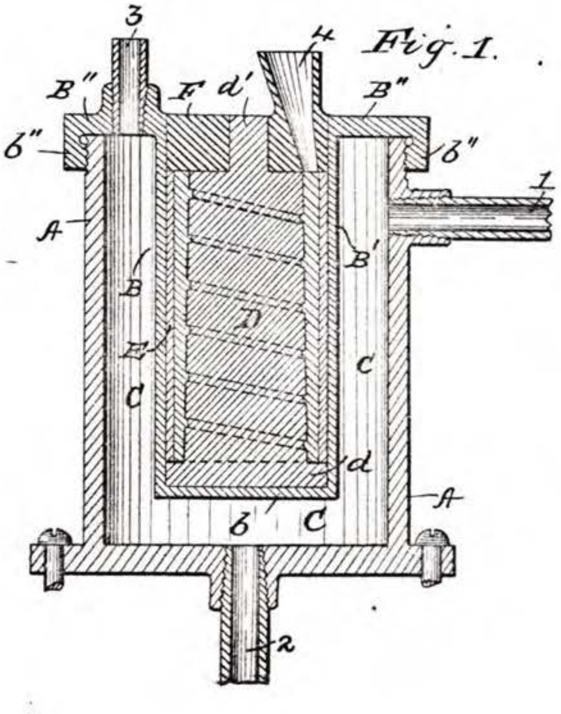
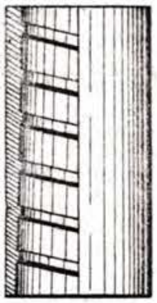


*Fig. 1.*

*Fig. 3.*



Witnesses
W. R. Edelen.

Inventor
Thomas H. Macdonald
by Philip Mauro
his Atty.

THE NORRIS PETERS CO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT.

## PROCESS OF MAKING SOUND-RECORDS.

**SPECIFICATION** forming part of Letters Patent No. 682,991, dated September 17, 1901.

Application filed November 3, 1900. Serial No. 35,351. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS H. MACDONALD, a citizen of the United States, and a resident of Bridgeport, Connecticut, have invented a new and useful Process of Making Sound-Records, which is fully set forth in the following specification.

This invention relates to improvements in sound-records and in the method of producing them by molding; and it consists in first superheating the material while in the mold and in then suddenly applying cold, whereby I obtain better results than heretofore possible.

The invention consists, further, in certain details to be hereinafter pointed out.

In order to explain my invention more readily, I refer to the annexed drawings, which show one form of apparatus for carrying out my process.

Figure 1 is a vertical sectional view; and Fig. 2 is a plan, partly broken away. Fig. 3 is intended to illustrate the improved sound-record.

The record is cast into a suitable mold, which is surrounded by a steam and water jacket for superheating and cooling the casting. This jacket consists of an outer shell A and an inner shell B for the mold, these shells inclosing between them the steam-tight space C. Shell A is closed at the bottom and open at the top for receiving shell B and is provided with valve-controlled inlets 1 and 2 for steam and cold water, respectively. Shell B consists of a hollow cylinder B', also closed at the bottom *b* and open at the top, and has an annular flange B'', that rests upon the top of shell A and is secured thereto, as by screw-threaded lip *b''*. Flange B'' constitutes the cover of the inclosed space C and serves to suspend shell B therein and is provided with the valve-controlled outlet 3. Core D has the base *d* fitting snugly in shell B' and resting on bottom *b* and at its upper end carries the stem *d'*. A suitable matrix E is fitted snugly into shell B to rest upon base *d*. A head F is inserted in the top of shell B and rests squarely upon the top of matrix E and core D, stems *d'* taking into a suitable opening in the head, which thus assists in securing the core in proper position. The annular space between the matrix and the core (constituting the mold) is thus inclosed by the base *d* and the head F. The head is provided with the funnel 4, forming an inlet for pouring into the mold the melted material that is to form the improved sound-record.

In carrying out my invention I proceed as follows: I fill the mold (through funnel 4) with the melted material, (soap mixture or the like,) which is hereinafter, for convenience, designated "wax," though I do not limit myself to a wax-like composition, since any suitable material or composition that can be readily handled may be employed and will come within the scope of my invention. I then admit steam through inlet 1 into the space C and heat the mold and its contents up to, say, about 350° centigrade and maintain the heat for some time, preferably until the entire mass of the wax is in a limpid state. This superheating forces out all air-bubbles from the mass of the wax and from the minute spaces in and around the irregularities in the matrix-surface, thus producing a more intimate relation between the molten wax and the matrix. After maintaining this heat for a length of time sufficient to drive off all bubbles and impurities I then admit cold water through inlet 2 and allow the steam to escape through outlet 3. This sudden application of cold chills the surface of the wax instantly and symmetrically and causes it to contract from the matrix-surface sufficiently to clear the now-solidified casting from the matrix and permit its withdrawal. The fact that the cold acts evenly from all sides causes the contracting to be even and regular, so that cracking, &c., are avoided. Moreover, owing to the abnormal compression or concentration of the molten mass during the period of superheating and also to the subsequent enormous force of contraction due to the sudden chilling of its surface, the sound-record molded by my process is much denser and harder on the surface than in case of an ordinary record made in the usual manner. It is, so to speak, "case-hardened" or tempered. Further, inasmuch as this symmetrical chilling effect takes place from the exterior of the mold and its casting I have discovered that with the composition at present employed (which is a mixture of two ingredients, as stearic acid and ceresin, both the hardness and the melting-point or solidifying-point of one ingredient being higher than those of the other) the first effect of this sudden exterior chilling is an initial reduction of the temperature to a point below the solidifying-point of the harder ingredient, which is thereupon converted into a thin shell or film, while the softer ingredient (still remaining liquid) is consequently forced inward. The result is as already indicated—viz., a casting whose exterior surface is much harder and denser than its mass, though the gradation is so gradual and imperceptible that there is no line of separation that might cause the outer casing to break off or the inner to shrink away.

Instead of admitting steam after the wax has been poured into the mold it may be admitted simultaneously or beforehand, as the object to be accomplished is the superheating of the molten mass and the maintaining of that heat. It is obvious that other means may be employed for superheating the material while in the mold.

Among the superior advantages of my case-hardened record so produced are that the mass being denser is less liable to be affected by changes of temperature and moisture and that being harder it is not so readily worn out by the action of a reproducing-stylus. Besides, while it would be difficult to engrave a satisfactory original sound-record upon a surface as hard as that produced by my process, yet by this process a sound-record equally as good as an original record is readily and cheaply produced in a more durable condition.

Of course I do not limit myself either to a cylindrical sound-record or to one of the type characterized by vertical irregularities, since the spirit of my invention consists in maintaining the molten wax (while in connection with its matrix) in a superheated condition and in then suddenly and symmetrically chilling it.

The record produced by the process herein described gives improved results in reproduction and is more durable than records made by direct engraving. In the latter the surface over which the reproducer-point rubs in reproducing is made by a cutting or scraping instrument having a blunt edge. When this surface is examined under a magnifying-glass, it is seen to be roughly broken, the molecules of wax having been disturbed and their adhesion to one another weakened. The reproducing-stylus rubbing over such a surface detaches these projecting particles, further roughening the surface, and causing scratching sounds in the reproduction. On the other hand, the surface of the molded record being formed by the cooling of melted particles strongly adherent one to another offers far greater resistance to roughening by the reproducer. Such records therefore have longer life than those made in the ordinary way.

The improved sound-record resulting from the process herein described is claimed in a divisional application filed May 21, 1901, Serial No. 61,267.

Having thus described my invention, I claim—

1. The process of molding sound-records which consists in filling a suitable matrix with a suitable composition, maintaining the same for a length of time in a superheated condition, and then suddenly and symmetrically chilling it, substantially as described.

2. The process of making a sound-record, which consists in pouring a suitable melted material into a suitable matrix-mold, then admitting steam into a jacket surrounding said matrix and continuing this step until the said material has become limpid and impurities are driven off and the said material forced into intimate contact with its matrix, then allowing the steam to escape and admitting cold water into the jacket whereby the said material is suddenly and symmetrically chilled from its exterior surface next its matrix, substantially as and for the purpose set forth.

3. The process of molding sound-records which consists in filling a suitable matrix with a suitable material and maintaining the same for a length of time in a superheated condition, and then suddenly and symmetrically chilling the same from the exterior inward, substantially as and for the purpose described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
W. R. MILLER,
W. C. LEWIS.

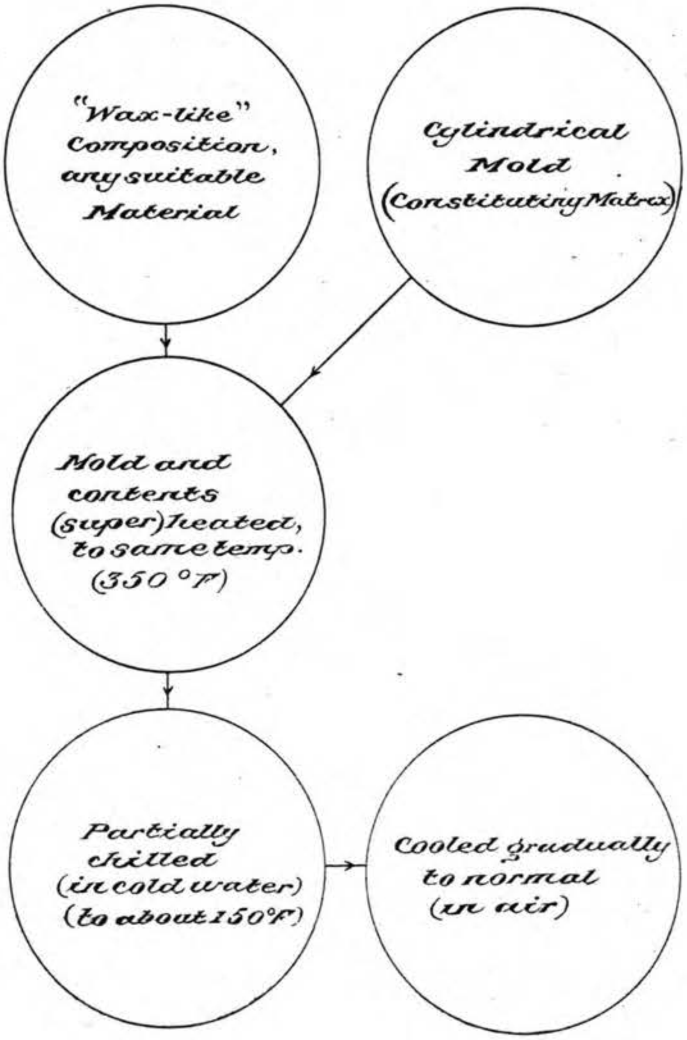
No. 773,801. PATENTED NOV. 1, 1904.

T. H. MACDONALD.

PRODUCTION OF SOUND RECORDS OR SIMILAR ARTICLES.

APPLICATION FILED MAR. 12, 1904.

NO MODEL.


"Wax-like" Composition, any suitable Material
Cylindrical Mold (Constituting Matrix)
Mold and contents (super) heated, to same temp. (350 °F)
Partially chilled (in cold water) (to about 150°F)
Cooled gradually to normal (in air)

Witnesses
Frederick A. Holton
Gustave R. Thompson.

Thos. H. Macdonald
Inventor
by
Mauro Cameron Lewis & Massie
Attorneys

THE NORRIS PETERS CO., WASHINGTON, D. C.

No. 773,801. Patented November 1, 1904.

# UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO AMERICAN GRAPHOPHONE COMPANY, OF BRIDGEPORT, CONNECTICUT, A CORPORATION OF WEST VIRGINIA.

## PRODUCTION OF SOUND-RECORDS OR SIMILAR ARTICLES.

**SPECIFICATION** forming part of Letters Patent No. 773,801, dated November 1, 1904.

Application filed March 12, 1904. Serial No. 197,865. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS H. MACDONALD, of Bridgeport, Fairfield county, Connecticut, have invented a new and useful Improvement in the Production of Sound-Records or Similar Articles, which is fully set forth in the following specification.

The present invention is an improvement in casting tubular or other bodies (sound-records or blank tablets) of wax-like or other material for use in the talking-machine art. There is a related process invented by me and described in Reissue Patent No. 12,095, dated March 10, 1902, for molding sound-records, which process consists in superheating the sound-record composition (commonly known in the art as "wax") after it has been introduced into the mold, and chilling it down from the superheated temperature.

The present invention is particularly advantageous when applied to a process wherein the wax is superheated, but is also applicable to any process wherein the molded article is chilled or reduced in temperature.

According to my present invention the mold containing the wax is heated, (preferably superheated,) as heretofore, the casting in the mold is then suddenly and symmetrically chilled from the exterior, as heretofore, except that the temperature is not reduced to normal by this first chilling operation, and, finally, the casting (having its temperature already reduced) is gradually cooled to normal and is then readily removed from the mold.

In carrying out the process set forth in my said reissue patent it sometimes happens that the sudden or severe chilling when carried too far has the effect of warping or otherwise injuring the cast record. The object of the present invention is mainly to overcome or avoid this difficulty.

In the preferred mode of carrying out my present invention the mold containing the wax-like material is superheated, and the mold and the limpid wax therein are brought to substantially the same temperature. Of course the mold may be heated first and the wax then poured in; or the mold may be superheated after the wax is in place, or the admission of the wax and the heating of the material may go on simultaneously. With the molds and "wax-like material" now in use I have found a temperature of about 350° to 375° Fahrenheit to give good results.

The two-step cooling process is satisfactorily carried out as follows: The heated mold containing the wax of about the same temperature is placed in cold water or is subjected to the action of cold water upon its exterior, care being taken that the water shall not act upon the wax within the mold and shall not very appreciably exert its cooling effects upon the interior or bore of the casting. This accomplishes the sudden and symmetrical chilling referred to in my said reissue patent as giving a good surface to the cast sound-record or other article, and this step is discontinued when the wax is chilled down to a point where it is in a plastic state, having a consistency about equal to very stiff putty. With the material now in use the water-cooling step may be continued for about five minutes, (if the wax has been heated to about 375° Fahrenheit,) at the end of which time the interior of the wax casting will be of a temperature of about 150° Fahrenheit, though its outer surface would of course be practically as cool as the mold. At this point the mold containing the casting is removed from the water-cooling treatment and is set in a cool-air draft, furnished by a rapidly-running electric fan, or the mold with its casting is otherwise subjected to a more gradual cooling effect. The air-cooling treatment reduces the temperature of the casting quite rapidly, though not so fast as the water would do. Employing the present record material, I find from five to seven minutes of air cooling is sufficient to complete the cooling of these molded articles. At the end of this time they may be lifted from the mold without any difficulty.

The material employed in carrying out this invention is preferably the composition described in my Patent No. 606,725, dated July 5, 1898, to which may be added a small amount of carnauba-wax or other hardening substance.

The drawing annexed hereto for convenient reference represents the successive steps in my process of casting sound-records. I have set forth these steps with some particularity; but the invention is not limited to the precise forms and details disclosed.

Having thus described my invention, I claim—

1. The process of casting by means of a mold, which consists in raising the mold and its contents to above normal temperature, then rapidly chilling the same but not to normal temperature, and finally gradually cooling same to normal temperature.

2. The process of casting by means of a mold, which consists in raising the mold and its contents to a higher temperature, then rapidly and symmetrically chilling the same from the exterior but not to normal temperature, and finally gradually cooling the same to normal temperature.

3. The process of molding sound-records or blank tablets, which consists in first superheating the mold and its contents and then cooling the same by a two step process, the first step being sudden and the second being gradual.

4. The process of molding sound-records or blank tablets, which consists in first raising the mold and the wax composition therein to a temperature of about 350° Fahrenheit, then chilling the same rapidly to a temperature of about 150° Fahrenheit, and finally reducing the temperature more gradually to normal.

5. The process of molding sound-records or blank tablets, which consists in giving the mold and its wax-like contents a temperature of about 350° Fahrenheit, then rapidly and symmetrically chilling the same from the exterior to about 150° Fahrenheit, and finally reducing the temperature gradually to normal.

6. The process of molding sound-records or blank tablets, which consists in first superheating the mold and its contents to about the same temperature, second rapidly chilling the same from the outside until the contents have become plastic and of about the consistency of very stiff putty, and finally reducing the temperature gradually to normal.

7. The process of molding sound-records or blank tablets, which consists in first superheating the mold with its contents, then chilling the same by the action of water but not as low as normal temperature, and finally chilling the same by air to normal temperature, substantially as described.

8. The process of molding sound-records or blank tablets, which consists in first having the mold of approximately the same temperature as the molten material therein, then rapidly and symmetrically chilling the same from the exterior to a temperature below the melting-point of the contents of the mold, then reducing the temperature of the same gradually to normal, and finally removing the cast article from the mold.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
M. A. Spalding,
C. A. Gibner.

# UNITED STATES PATENT OFFICE.

HENRY F. H. MILLER, OF BOSTON, MASSACHUSETTS.

## IMPROVEMENT IN WATER-PROOF COMPOUNDS.

Specification forming part of Letters Patent No. **178,319**, dated June 6, 1876; application filed November 27, 1875.

*To all whom it may concern:*

Be it known that I, HENRY F. H. MILLER, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Water-Proof Boot and Shoe Polishing Wax; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it pertains to make and use the same.

My invention relates to a new article of manufacture for the purpose of polishing boots and shoes, &c., without the need of a brush. By the use of this my invention the leather is rendered very soft, glossy, and pliable, and preserved from decay, as well as rendered water-proof and water-repelling.

This my invention is molded in a convenient shape, so as to be carried in one's pocket, if required, without soiling the same, and, as a dressing, it is particularly applicable to boots and shoes in moist and damp weather, when it will protect the feet thoroughly from dampness.

The manner in which my invention is used is simply to rub the wax lightly over the boot or shoe, and then to rub or polish it gently with a cloth of any suitable material, although cotton cloth is preferable for this purpose. Boots or shoes dressed and polished with my invention may be exposed to dampness and water without affecting the polish thereon, or allowing the moisture and water to penetrate the same.

My invention is composed and made as follows: About ten pounds of paraffine-wax, six pounds of stearic acid, and four pounds of beeswax are heated and melted together in a suitable vessel. I then add about two pounds of ivory-black, one and one half pound of lamp-black, three ounces of gum-dammar, ten ounces of pulverized sugar, one-half gill of high-proof alcohol, one-half gill of spirits of turpentine, and three ounces of bar-soap.

The above is kept stirred while being brought to boiling, and also when it is put into suitable molds, after which it is allowed to cool, and is then ready for use.

What I claim, and wish to secure by Letters Patent, is—

The water-proof boot and shoe polishing wax, as herein described, composed of paraffine-wax, stearic acid, beeswax, ivory-black, lamp-black, gum-dammar, sugar, alcohol, spirits of turpentine, and bar-soap, in or about the proportions specified.

In testimony that I claim the foregoing as my own invention I have affixed my signature in presence of two witnesses.

HENRY F. H. MILLER.

Witnesses:
ALBAN ANDRÉN,
SARAH M. MILLER.

# UNITED STATES PATENT OFFICE.

CHARLES SUMNER TAINTER, OF WASHINGTON, DISTRICT OF COLUMBIA.

## TABLET FOR USE IN GRAPHOPHONES.

**SPECIFICATION forming part of Letters Patent No. 393,190, dated November 20, 1888.**

Application filed November 19, 1887. Serial No. 255,662. (Model.)

*To all whom it may concern:*

Be it known that I, CHARLES SUMNER TAINTER, of Washington, in the District of Columbia, have invented a new and useful Improvement in Tablets for Use in Graphophones, which improvement is fully set forth in the following specification.

This invention has reference to the preparation of a recording surface or medium for graphophones, or apparatus for recording and reproducing speech and other sounds, wherein the sound-record is cut or graven by a cutting-style. In such apparatus the recording medium or composition (usually wax or a wax-like substance) is spread in a thin layer on a suitable base or foundation—such as paper or pasteboard—constituting what is termed the "tablet." Very few substances are found suitable for this purpose, as properties or characteristics of a peculiar kind are essential to the production of an accurate record—one that will not be impaired by lapse of time and which will give loud and clear reproduction.

In an application filed by me November 14, 1887, and numbered 255,082, I have set forth the principal difficulties encountered in the preparation of a recording-tablet and the reason why most of the waxes commonly known and mixtures of them are unfit for the purpose. It will not, therefore, be necessary to repeat such statement here, it being sufficient to say that the present invention consists in certain waxy compositions which have been found to possess the necessary characteristics to render them suitable as the recording medium of graphophonic tablets.

A number of common waxes—such as beeswax, for example—have certain properties that are advantageous and useful, but lack hardness and resistance to changes of temperature and other conditions requisite to successful employment. Beeswax, for example, cuts smoothly, but is too soft and sticky. It has been found that waxes of this nature can be rendered suitable for the use desired by an admixture of a proper proportion of a substance known as "carnauba-wax." This wax itself is very hard and brittle, and, in cutting, chips off in small particles; but it mixes readily with beeswax and waxes of like nature and forms a compound eminently suitable for the recording-surface of a graphophonic tablet. Among other substances with which the carnauba-wax may be mixed, and which for this purpose may be regarded as the equivalent of beeswax, are cerasine-wax, paraffine, and bay-wax—sometimes called "bayberry" or "myrtle" wax.

In preparing the mixture, I take from fifteen to forty per cent. of carnauba-wax to from sixty to eighty-five per cent. of the softer wax—such as white beeswax. The maximum proportion of carnauba-wax is used in warm weather, and at high summer heat will render the mixture sufficiently hard. At more moderate temperatures a smaller amount of carnauba-wax is preferably employed.

The waxes, in the proportions indicated, are melted and thoroughly mixed together, and are applied to the base or foundation of the tablet in any suitable way.

I claim—

1. As the recording medium for graphophonic records, a waxy composition containing carnauba-wax in admixture with other softer wax, substantially as described.

2. As the recording medium for graphophonic records, a mixture of carnauba-wax and beeswax, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

CHARLES SUMNER TAINTER.

Witnesses:

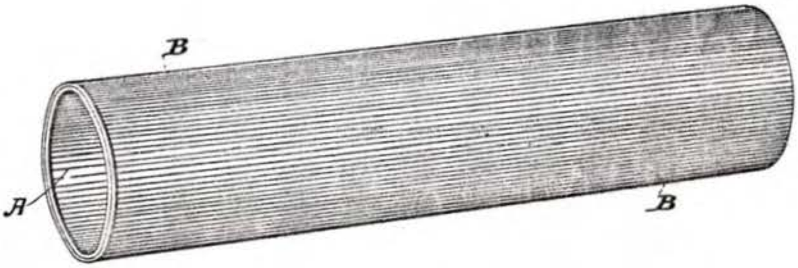
HARRY M. PAYNE,
PHILIP MAURO.

(No Model.)

C. S. TAINTER.

GRAPHOPHONE TABLET.

No. 421,450. Patented Feb. 18, 1890.



Attest:

Geo. T. Smallwood.

Philip Mauro

Inventor:

Charles Sumner Tainter by

A Pollok his attorney.

N. PETERS, Photo-Lithographer, Washington, D. C.

# UNITED STATES PATENT OFFICE.

CHARLES SUMNER TAINTER, OF WASHINGTON, DISTRICT OF COLUMBIA.

## GRAPHOPHONE-TABLET.

SPECIFICATION forming part of Letters Patent No. 421,450, dated February 18, 1890.

Application filed November 14, 1887. Serial No. 255,082. (No specimens.)

*To all whom it may concern:*

Be it known that I, CHARLES SUMNER TAINTER, of Washington, in the District of Columbia, have invented a new and useful Improvement in Graphophonic Tablets, which improvement is fully set forth in the following specification.

This invention has reference to the preparation of a recording surface or medium for graphophones or apparatus for recording and reproducing speech and other sounds wherein the sound-record is cut or graven by a cutting-style in a surface, such as wax or waxy composition. For a description of such apparatus reference may be had to Letters Patent No. 341,214, dated May 4, 1886, No. 375,579, dated December 27, 1887, and No. 341,288, dated May 4, 1887.

The recording medium or composition is spread in a thin layer on a suitable base or foundation—such as paper or pasteboard—constituting what is termed the "tablet." The form of the tablet is usually either cylindrical or flat, though of course they could be of other forms, and the shape of the tablet forms no part of this invention.

There are certain properties or characteristics in the recording medium that are desirable or essential to the successful operation, and which are difficult, owing to their somewhat contradictory nature, to find combined in one substance. It is necessary that the substance be of the right degree of hardness and toughness without being brittle, and that it should not be susceptible to changes of temperature. Some waxes are too brittle, and instead of cutting smoothly and accurately under the cutting-style chip or break off, producing, of course, an inaccurate record. Even a slight degree of brittleness will unfit the substance for the use designed, and as a general rule those waxes that are sufficiently hard and fine in texture for the purpose have also the undesirable property of brittleness and lack toughness and coherence. Other waxes—such as beeswax, for example—while cutting smoothly and evenly, are too soft and too susceptible to alternations of conditions under changes of temperature. Such waxes also become sticky, the shavings adhere to the record and other parts of the machine, and their use is attended with other inconveniences. Soft waxes, moreover, do not give in reproducing as loud or distinct articulation as harder waxes.

Heretofore a composition of beeswax and paraffine has been used with good results, but it does not possess the essential characteristics in as high degree as desirable.

I have found after a long series of experiments that a certain natural or earth wax known as "ozocerite" is eminently suitable for the purpose of forming graphophonic recording-surfaces, particularly when treated as hereinafter described. This wax is tough and smooth in texture. In recording it cuts out in a continuous shaving without breaking into short pieces or adhering to the tablet or other part of the machine, and it cuts off close to the point of the cutting-style without chipping off below the same, and therefore produces an accurate record. In color it is brownish black in its crude state, but when treated as hereinafter described it becomes quite black and has a glossy surface and is opaque. This characteristic of color is useful, as it makes the lines of the record more distinct. On a light-colored surface the fine lines are very difficult to recognize. Defects or irregularities in the paper base or foundation, which are discernible through a semi-transparent wax, are completely hidden by the ozocerite.

In making a tablet the wax surface is applied by melting the wax and applying it while in a fluid state. On cooling the wax contracts more than the paper foundation, and on this account many of the compositions tried have cracked on cooling, rendering the tablet useless. The use of the ozocerite wax, however, is not attended with this disadvantage.

In forming a tablet with ozocerite wax it is advantageous to concentrate the crude wax by the application of heat until it loses from ten to thirty per cent. of its weight, which renders it much more suitable for the purposes of the invention. After concentration by boiling it becomes harder and tougher, changing in color from a brownish black to a deep black. It is then applied in a thin layer or coating to the foundation of paper or other material, and on cooling is turned down until a perfectly smooth surface is obtained.

In heating the ozocerite wax a high temperature is necessary, in order to produce the concentration desired. At 250° Fahrenheit the vaporization proceeds very slowly, and it is customary to employ a temperature of 400° Fahrenheit and upward. The duration of the treatment will, of course, depend on the temperature employed.

The ozocerite wax may be employed alone, and it is sufficiently cheap for the purpose. It may, however, be combined with other waxes. It mixes readily with beeswax, carnauba-wax, and others, and its use in such compositions would be within the scope of the invention.

In the drawing, which is a perspective view, I have shown, by way of example, a cylindrical tablet. A is a base of paper or other suitable material, which may be constructed, as described, in my patent, No. 374,133, dated November 29, 1887. B represents a coating or layer of ozocerite wax. The latter having been concentrated, as before explained, is applied to the tablet in any suitable way. This may be done by immersing the tablet in the liquefied wax a number of times until a coating of sufficient thickness is obtained. The wax coating is then turned down until the surface is perfectly smooth. It is not necessary that the coating B should be more than one-fiftieth of an inch in thickness.

I claim—

1. A tablet for graphophonic records, having a recording-surface consisting, essentially, of ozocerite wax, substantially as described.

2. A tablet for graphophones, comprising a foundation of paper or other suitable material having a surface coating of concentrated ozocerite wax, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

CHARLES SUMNER TAINTER.

Witnesses:
R. M. READ,
PHILIP MAURO.